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ARCHITECTVRE

ENGINEERING

DECORATION

CONSTRVCTION

TICKNOR & COMPANY

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Tomb for an Illustrious Architect.
Williams Institute, New Haven, Ct.
Designs for a Coal Office.
Designs for a Gate-Lodge.
Design for a Clock-Tower.
House on Fifth Ave, New York.

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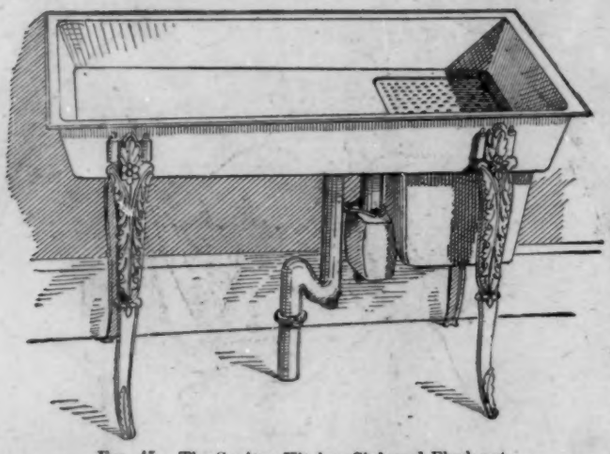

FIG. 45. The Sanitas Kitchen Sink and Flush-pot.

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It is absolutely automatic in its action, and to this feature is largely due its great success.

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MANY of the foreign papers contain descriptions of the illuminiated fountains which form so great an attraction at the Paris Exhibition. The idea of throwing colored light upon jets of water is by no means new. Nearly every mountain watering-place has its illuminated cascades for the entertainment of visitors, and at the last three English exhibitions illuminated fountains were very skilfully and successfully shown. The enclosure of the Champ de Mars offering unusual facilities for an exhibit of this kind, the managers of the affair appointed M. Formige, one of the principal architects connected with the Exhibition, and M. Bechmann, the chief engineer of the Paris water-service, to prepare a scheme for lighting such fountains as they might think advisable in the most effective manner. The two gentlemen proceeded at once to England to collect information, and on their return devised the scheme which has been carried out. The fountains of the Champ de Mars are situated in an oblong basin, containing one very large fountain, or group of jets, which can be changed at will, fourteen smaller fountains, and an extensive cluster of jets, surrounding a sculptured group, representing the genius of France in a chariot. The illuminated fountains shown at London and Glasgow had been purely artificial, consisting of jets of water thrown by a powerful steam-pump, which uses the same water over indefinitely, but on calculating the cost of the pumps and motive power necessary for propelling so large a body of water as the experts desired to use at Paris, it was decided that it would be more economical, as well as better, to use a special supply, which was obtained from one of the reservoirs on the Seine, four or five miles from Paris. To illuminate the water instead of simply throwing a ray of light upon it from the shore, as is commonly done, the lights were all placed under the jets, by means of a tunnel, which ran at some distance below the surface of the lake, and was furnished with syklights of thick glass directly under the centre of each fountain. In the tunnel were electric arc-lights of various powers, with reflectors to concentrate the rays in the desired direction. Some of the arc lamps were automatic, of the usual kind, but many were simply pairs of carbons, which were made to approach by hand as they burned away. To illuminate the extremities of the spreading jets, special reflectors were necessary, and this does not seem to have been quite so successfully done as the illumination of the high jets by the lamps directly under them. All the jets, which were in many cases made to turn in various directions, were controlled from a little pavilion near the lake, and from this were sent out by electricity the directions to the workmen in the tunnel. The coloring of the light was also managed directly from the pavilion, by the simple process of connecting a large number of sheets of colored glass together in the form of a chain, which passed between the lamps and the skylights. By arranging the colored panes at suitable distances, the fountains were made to change simultaneously in tint all over the lake, by giving a turn to the windlass which actuated the chain. As a refinement on this, however, subsidiary lamps and colored screens were arranged, so that different portions of a given fountain might be made to show different colors at the same time. In order that the air around the fountains might be perfectly clear of dust, which would otherwise reflect a portion of the light, and show the course of the rays, the fountains were made to play a few minutes before any light was thrown upon them, so as to wash the surrounding atmosphere completely.

A RATHER curious arbitration case is reported in the *Revue Industrielle*. There is a law in France that when arbitrators are appointed, unless the agreement by which they are appointed fixes the time within which they shall render their award, the award must be made within three months after their appointment. In the present case, Mr. A and Mr. B had a difference as to the settlement of an account, and agreed to refer the matter to Mr. C as arbitrator. This was in November. In December Mr. A gave notice that he had concluded not to have Mr. C as arbitrator. Mr. B appealed to the court, which decided that Mr. A could not withdraw from his agreement, and Mr. C went on to inquire into the circumstances, and make his award, which was delivered toward the end of February, more than three months after his original appointment. The award was very unsatisfactory to Mr. A who refused to abide by it, on the ground that it had been made after the expiration of the legal period, and was therefore void. Mr. B claimed that as Mr. A by withdrawing from his agreement, and making it necessary to apply to the court to compel him to keep to his contract, had been the sole cause of the delay, he could not invoke a circumstance brought about by himself as an excuse for escaping from his agreement. The Tribunal of the Seine, however, found that no distinction was made in the Code as to the causes by which the award of an arbitrator might be delayed, and ordered that in this case the award should be set aside as illegal.

A NEW roofing material is mentioned in the German papers, in the shape of a sort of metallic slate, somewhat similar to those used among us but, enamelled so as to be proof against moisture or acid vapors. Metallic slates of tin and galvanized-iron have long been used in Germany, and galvanizing has been pronounced by the highest scientific authority there to be the best protection against rust that has yet been applied to iron, but it is acknowledged that the bending necessary to form the locking joints of the metallic tiles is apt to throw off the protecting covering, leaving the iron exposed to corrosion. In order to provide against the bad effects of this, the new plates are made of sheet-iron, stamped into shape in the usual manner, and are then dipped into an enamel paint which, when heated, forms a continuous coating, unaffected by acids or alkalies. It is too soon to say how long a roof laid with such a material will last, but it promises to be of considerable value.

A VERY interesting discussion took place the other day at a meeting of the Royal Institute of British Architects, following the reading of a paper by Professor Aitchison, on the Roman Baths. Professor Aitchison, who described himself as an old Turkish bather, somewhat familiar with athletics, and still interested in the classical studies of his youth, has made careful examinations of the Roman baths which are still accessible, and, as usually happens when architects study antique buildings, has added much to the knowledge of the subject. According to him, the baths of Rome were at once the exercise-grounds, the music and lecture halls, the public gardens, the club-houses, the picture and sculpture galleries and the places of social enjoyment of the well-bred people of Rome. In his opinion, the use of them as lounging-places, where many persons spent most of their time, was favored by the imperial government, which found it good policy to encourage political discussion in public places, instead of compelling it to take refuge in the secret chambers of conspirators. Both for this reason, and on account of the popularity which followed the devotion of money to this purpose by rich aspirants for political honors, the baths founded by such men as Agrippa, Diocletian and Caracalla, became the most splendid structures of the Roman period. In all of them the floors were of marble mosaic, one of them having had, it is said, steps of gold quartz leading down into the plunge-bath, so that the veins of gold could be seen through the water, while all, except that of Agrippa, had

their vaulted ceilings covered with glass mosaic, after the style of that at Ravenna, and were adorned with the most beautiful Greek statues that could be procured. More than this, recent investigation has shown that they exhibited some methods of construction which had been supposed to be peculiar to modern architecture. For example, the baths of Caracalla contained a room, used for a swimming-bath, which was one hundred and eighty feet long, and seventy-six feet wide, and had a flat ceiling. As the Romans were not accustomed to make their ceilings of furring joists and laths, it has long been a question how this particular one was managed, and the description of Aelius Spartianus, who says that it was "built with latticed beams of bronze, which carried the roof in such an extraordinary way that persons in those days declared that it was then impossible to do anything like it," had not done much to clear up the mystery, until Professor Lanciani, in 1873, having had the basin of the swimming-bath excavated, found in it a great number of fragments of wrought-iron beams, of T-section, with bars of iron of similar section, imbedded in masses of concrete. The appearance of the fragments seemed to him to show conclusively that the ceiling was supported by the T-iron girders, connected, possibly, into some form of truss, and carrying cross-bars, which was afterwards cased with concrete, much as floors are built in Paris. No signs of bronze were discovered, and it is probable that it was used only as a casing over the trusses or girders, and was carried off by the barbarians who plundered Rome during the dark ages of everything in it which seemed to them valuable.

A CURIOUS accident took place in Boston the other day. A wooden house, which had been ordered to be vacated by the Board of Health, had ever since served as a lumber-yard for the poor people of the neighborhood, who replenished their stores of kindling-wood by pulling off the boards and chopping away such of the timbers as they could get at. This process had gone on so far that the more prudent of the wood-gatherers had concluded that their occupation was dangerous, but the more careless ones kept on with their work until, one evening, the building fell on top of them, injuring several. Fortunately, the structure was so frail and light that no one was absolutely crushed, and the sufferings of at least some of the wounded will be alleviated by the reflection that a fresh store of kindlings has been opened to them by the catastrophe.

THE sort of invention typified by the phonograph appears to to have been carried to its utmost limit in a suggestion which was recently made before the French Academy of Sciences. It seems that some one has invented a sort of photographic camera which will take a series of photographs of any object at intervals of one-tenth of a second, and the academician in question proposed that in using the phonograph one of these cameras should be adjusted in front of the person who was speaking into the phonograph, so as to secure a photographic record of the expression of his countenance while the conversation lasted. On sending to its destination the tin-foil sheets of phonographic writing, a proof from the photographic record of the speaker's expression would be sent with it, and on placing the proof in a cylinder, revolving at the same speed as the cylinder of the original camera, the person receiving the message, by placing his eye at the cylinder, and his ear at the phonograph, would be enabled to see, as well as hear, his friend talking to him. Whether this would be an advantage which many persons would prize is a difficult question, but it is not amiss to remember that a slight slip in the synchronism of the cylinder and the phonograph would lead to such horrid results that no one would wish to run the risk of meeting with such an experience a second time. By the way, it seems to us a little strange that no one has yet utilized the phonograph as a piece of theatrical property. Even among the novelists, we do not know that a phonograph has yet led to the detection of a criminal, or the rescue of a heroine from inevitable death, or the reconciliation of an estranged pair, and on the stage such a contrivance would be tenfold more effective than in the pages of a book. We think we could offer some valuable suggestions ourselves as to the construction of a phonographic plot, and commend the subject to the attention of dramatic writers.

THE *Schweitzerische Bauzeitung* describes the new Chinese railway from Tientsin to Kaiping, and gives an account of the way in which the right-of-way was secured in difficult cases, which appears to be not without its merits. The line is about ninety miles long, with a single track, and is equipped in the most primitive fashion. The signals consist of flags, which are waved by the station-masters, and the setting of the switches and the other operations of traffic are performed in a similar way. For all this, the road is well patronized, and does a large business at profitable rates. The trains consist of both freight and passenger cars, together with cars which partake of both qualities. The first car after the engine is the second-class car, and consists of a long, narrow vehicle, divided longitudinally through the middle. The passengers enter at the ends and arrange themselves on long benches, two of which run along the sides of the car, while the other two are set with their backs against the central partition, like a double horse-car. Next to this car, which is used by the small merchants and persons of similar rank, comes the third-class car, which consists of a large box for baggage and freight, surrounded by a bench, and covered with a roof of tarred felt. The first-class car brings up the rear, and is simply an ordinary American car. The road is well built, and the bridges are particularly well designed, being arranged, also, for receiving a double track at some future time. In regard to the way in which land damages were settled, one of the native Chinese papers tells a little story: In the district of Tichia, near the Tientsin River, dwelt three proprietors, named Haw, Li and Pheng, whose land was crossed by the line of the proposed railway. Like many more civilized proprietors, these gentlemen refused to accept the liberal price offered them by the railway officials for a right-of-way across their territory, and demanded more. Finding their representations unavailing, the railway directors referred their antagonists to the local magistrates, who were equally unable to persuade them to reduce their demands. The higher authority was then appealed to, and an energetic official despatched to the spot. He saw the three gentlemen, presented the case, and begged them to reconsider their determination, but to no purpose. He then called in the assistance of the secular arm, and ordered Pheng to be seized and treated with one hundred blows of the bamboo. After this he was set up in the stocks, with a log of wood chained to his neck, and was told that he was to remain there for three days, and if at the end of that time he remained unconvinced by official reasoning, more severe measures would be resorted to. Before the three days had elapsed, however, he had changed his mind as to the value of his land, and consented to convey the right-of-way in return for the sum offered him, and his two friends, who had witnessed his experiences, concluded that a similar arrangement would, on the whole, be satisfactory to them.

WE have become somewhat callous to the complicated perils that surround our daily life in large cities. As we walk through the streets we are forgetful of the fact that at short intervals there are stored under the sidewalks boilers enough to annihilate any city by their simultaneous explosion. We no longer hesitate to take into our buildings for heat and power that gigantic servant superheated water, of the real strength of whose fetters we are really ignorant. We bring water to our cities from huge reservoirs the failure of whose walls may wipe out of existence, lives and property of untold value, and we trust to the pressure of an inch or two of water-seal to keep pestilence from reaching our dear ones from the sewers. It is a happy-go-lucky age, but experience is every day teaching us that no safeguard can be neglected in controlling even well-known forces. Just now she is showing us how wily and unsubjugated a slave is electricty, and her lessons are enforced with hard blows, death, fire and destruction. Now a heavy man-hole cover is hurled into the air because gas collected in a subway has become ignited by a spark; now some unfortunate is shocked to death because he has unwittingly touched a live wire, and now one's house is burned down because a live wire has crossed the wire of the ubiquitous domestic telephone. The explosion in the new Fisk Building, Boston, this week, which inflicted serious injuries on several occupants, is a new manifestation of its untamed savagery. In some way gas had escaped from the pipes and filled the spaces in the hollow-tiles between iron floor beams. A cross-circuiting of the wires even if it did not, as some assume, cause the leak seems to have given vent to the spark that ignited the gas and caused an explosion violent enough to partially wreck two floors.

AN ARCHITECTURAL KNOCKABOUT. — I.

I LEFT New York on the morning of the 17th of December, 1887. The weather was cold and clear. I had come aboard the ship the night before — or, put it, well into the morning; for I had been tendered a farewell dinner by my brother-draughtsmen, which was of a convivial nature — as artistic dinners are apt to be.

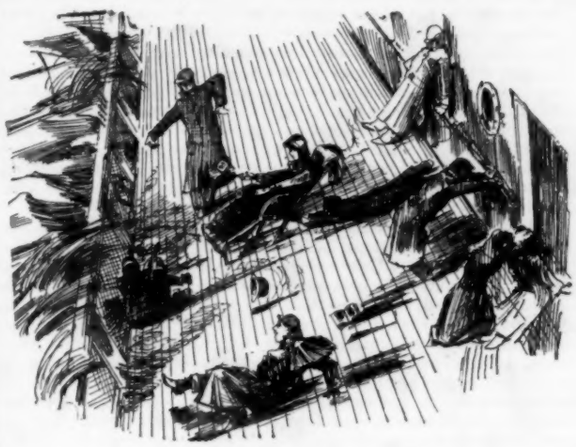
I had embarked on the good ship "*Westernland*," of the "Red Star" line, for Antwerp, and it was my intention to land there and then proceed on through Belgium and Holland. Nothing can describe the mingled feelings that assailed me as we cast off from the pier and dropped silently down the North River with the friendly aid of a tiny tug-boat. My travelling experience was at that time extremely limited, being confined mainly to the areas of Massachusetts and New York State. As we moved out into the ocean, I wondered how it would all end, and if there was actually any other land in the world than that shown in the splendid panorama spread out before me, which I was then viewing from the after-deck of the steamer.

Almost simultaneously with our departure, four or five other steamers of the various lines got under way, and the stately progress of these great ships with their different national colors displayed, made one of the most beautiful lights I have ever seen. They tell me that a traveller's first impressions of such scenes as these are never equalled in the future. Perhaps that is true; in my own case, they were certainly unique.

After we had gotten out of the harbor, our little tug-boat left us, with a *bon voyage* from the deck, and our mighty vessel moved rapidly away, propelled by its own great strength. I watched the fast-disappearing land for a long time, and it was with a feeling of sadness that I waved a farewell to my home and country. I then resolved to "brace-up," and immediately proceeded to examine the internal arrangements of the vessel which was to be my ocean-home for ten days.

Approaching the "Banks" it grew rapidly rough, and I had opportunity soon enough to test my sailing-qualities. They proved good — really quite too good — as no one but myself appeared for a long time on deck, and I almost believed that the captain and I were running the ship alone. Gradually a few sad men appeared on deck, whom I did not, of course, know; but that was no drawback, as no one requires a formal introduction on board ship, where there are so many opportunities for contact. The sympathy for illness — the rushing after, and rescue of, a lady's hat — the preservation of a galloping steamer-chair with its fair burden — are but a few of the many chances for acquaintance which a man has on board an ocean-steamer.

It was impossible for me to be seasick, although I tried to bring it about from sheer loneliness. I did the most daring things. I ran about the decks while they were at an angle of forty-five degrees, and every ocean-traveller who has experienced the miserable feeling of trying to walk or run on a level deck which suddenly rises or falls before him, will agree that it usually accomplishes the result I desired. Then I hung over the railing and suggestively gazed into the seething waves, but still with no nauseating effect. So I gave it up. Time went on, and I soon knew everybody. We numbered only sixteen first-cabin passengers, as this was the least favorable time of the year for a voyage, but there were some interesting people among them. To begin with, a gentleman and his wife with two pretty daughters (which fact I was not slow in discovering when at last they appeared on deck). Then there was a railroad superintendent and his wife, a ship-owner and his wife also; and a dear old lady, a native of Bruges, who had been to America to close the eyes of her only son, and to see him laid to rest on a foreign shore. She was very kind to me, and taught me French, to my constant embarrassment, for the lessons were all given at the table in the presence of all the other passengers. She would ask me the most awful questions, using the most idiomatic of idioms, and keep it up until I made some sort of answer, to the amusement of the whole saloon. She was a great help to me, however, and I shall never forget my friend from Bruges, who used to tell me that I reminded her of her lost boy. We also had with us a jolly minister from Boston with his wife and child — that child, by the way, was rescued from imminent danger of the briny deep by every individual person of the ship's company, at odd intervals. We had, moreover, a large percentage of the artistic element, as there were two brothers, young architects from Rochester, who were going abroad, as I was, for study and sketching. With these I soon struck up a great and, I hope, a lasting friendship. Then last, but as we soon discovered, not least, was a New York *Herald* reporter of the traditional type, who ate most of the time, and smoked scented cigars all the rest. However, he too became one of "our family," and his stories of the heroic deeds he had performed in order to get items for his paper, were worthy of a monument, every one of them. It was a jolly party when finally they all got well enough to sit up and smile faintly. The pretty girls were kind to us, and we (the architects) did our best to amuse them. We drew caricatures, sketched the sailors, drew in their albums — the same old story — and generally made ourselves as agreeable as we knew how to be. We had all been given the "liberty" of the ship, and in that great "*Westernland*" the sixteen cabin-passengers seemed almost lost on the huge decks; but, on the fifth day out, everything, without permission, took the "liberty of the ship," indeed.



I shall never forget that night! We had run into the tail-end of one of those terrible winter storms, and it was fearfully rough. The ship seemed fairly to stand on end. Her bow plunged far down into the sea, while her stern emerged as much in the air. Her great screw, released from the pressure of the water, whirled about with the most soul-stirring noise imaginable. I can see myself now, clinging with both hands to my berth, while my portmanteau, tooth-brush, boots, and indeed, everything movable I possessed, was flying about the room. Then the rolling! One motion at a time is quite sufficient for misery, but when one undergoes the roll and the pitch simultaneously, one asks oneself, why one was born. However, we survived the discomforts of the night, but it was, for me, with the loss of several articles of apparel which I was never able to find afterwards, even when the ocean became more tranquil.

We proved to be badly out of our course, and the captain informed us that it was doubtful if we should reach Antwerp for seven or eight days more. This was disheartening, but one has to accept the inevitable on such occasions, without a word of protest. The next evening, all who were able assembled in the smoking-room. We had expressly requested that the ladies might share our quarters there, provided they would submit to the tobacco-smoke. They acceded to this proposition instantly, and we tried to amuse them by songs and stories, but it must be confessed that our efforts were not all successful. It was the night before Christmas. The day had been rainy and stormy, just the sort of weather to make any one miserable who was away from home on that great festival. To say that I was homesick, would be putting it mildly, and every one seemed to share my feeling. But something had to be done to relieve the universal gloom that pervaded our company, and I had pondered within myself all day to devise something to raise our spirits. At last I hit upon a scheme which I modestly thought might accomplish this object, and it was on this evening that I distinguished myself, though I felt as if I should extinguish myself at the same time.

I am, every now and then, gifted with a slight ability to caricature people and things, and am at those times filled with a desire to be funny, although it is hardly necessary to say that I am not always entirely successful. The scheme I had thought of, to act as a "starter" to the assembly, was to give an amateur lecture on caricature. My knowledge of the history of this art was somewhat limited, but I considered that nothing mattered in the face of the desperate depression which pervaded my prospective audience. The great Hogarth was to figure as my grand *coup*, and I rushed to my state-room and wrote a little essay, making it as ridiculous as I could. I prepared, also, some sketches of all of us, with caricatures of our dress and manners. I then went to the captain, told him my plan, and asked his advice. He thought it a noble scheme, and was really glad to have some sort of celebration to wake us all up; so he promised to supply me with a black-board, and agreed to grace the assembly with his presence. At dinner he announced that "our young friend," etc., would give a little entertainment in the smoking-room on this, the night before Christmas, and that a full attendance was desired. This pleased the passengers very much, and, accordingly, there they all were, as many as were able.

At eight-thirty, then, I rose, feeling very much embarrassed. The captain, in full uniform, and all the company in their best clothes, gazed at me with the most extravagant expectations, and I began to speak, somewhat in the following words: "Ladies and gentlemen, I really do not know what I am talking about, but, owing to the state of the weather and the apathy into which we have all fallen, and considering that this is Christmas Eve, I have resolved to sacrifice myself and my feelings to your amusement, even at the risk of being thrown overboard. So here goes!" (Applause.) I then attempted to give a little history of the art of caricature, so far as I knew it; then proceeded to show how we all caricature ourselves in our speech, manners and dress, drawing on the black-board quickly as I talked. My remarks being met with the most flattering applause, I continued speaking just as the ideas occurred to me, meanwhile watching my audience narrowly to see how much they would stand. I made my great point when I caricatured the ship's course, amidst the roar of the passengers and the hearty laughter of the captain, who rubbed his hands in glee, as if he enjoyed beating around on the ocean "just for fun" in December. Finally, I ended my lecture by saying: "All things in the world can be caricatured. No," I interrupted myself, "I make a mistake. There must be an exception to every rule; and, as I look around the room here at the ladies present, I see without question that true beauty can never be caricatured." Whereupon I made a rapid sketch of the two pretty girls from a little drawing of them both that I had captured once when they were reading. This hit was very well received, and I retired on my laurels. The captain behaved splendidly, and ordered up the most elaborate of suppers, topping the whole thing off with some delicious Welsh rare-bits. Then we all wished each other a good-night and a merry Christmas and retired. The next morning the steward woke me early to present me with a pipe, a box of cigars and several other things from "the grateful passengers." It was most kind of them, and I appreciated it greatly.

After this everything seemed to brighten up. The weather got better, and the pretty girls seemed to be kinder. As to the latter, we three architects were compelled to resort to a private arrangement of our own to insure a fair division of the spoils, which was usually the tossing up of a lucky quarter. (They used my quarter generally, and, strange to say, it seemed to know its owner pretty often.) We were able to play "ring-toss" on the deck, and on one day we had a "cake-walk." I will not say who won, except that one of the pretty girls was "in it." One night I shall never forget. The moon was shining brilliantly, and the air was just balmy enough to be harmonious with the moon. We "young things," as the rest called us, were sitting out on a tarpaulin-covered hatchway at the stern of the ship. (I must be allowed to remark that the reporter was not allowed in this moonlight group; we were three men to two girls as it was.) Then we began to sing. The two girls sang beautifully, and when we fellows joined in with bass, baritone and tenor, we thought the harmony delicious. What could have been more beautiful altogether than the effect of our great ship then? We could see the whole length of her as her bow rose slowly and grandly, far, far up on one of the long ocean swells, while the rolling sea all around us caught and reflected the soft moonlight. The voices of

the girls blended sweetly with our deeper masculine tones, and we all enjoyed ourselves thoroughly, while our elders listened and looked on with smiling approval. The jolly Boston minister made himself distinctly famous by singing to us a song of the most melancholy nature, which he rendered quite tragically, weeping at all the affecting parts It was a gruesome tale about "Gorging Jack and Guzzling Jimmy, and no one else save little Billee," and, when we had learned to join in the chorus with the same pathetic feeling, we sang it on every possible occasion.

One night we sighted the faint light of an America-bound steamship — so strange a sight out there in that great expanse of water. The captain wished to ascertain her name and line, so he gave orders to signal her. We displayed three red fires — one at the bow, one at the stern and one amidships — and kept them there until they burned out. Soon we saw an answering signal, and, although it was so far away that it was hard for us to distinguish the number or the color, the captain informed us that she was one of the North German Lloyds.

Our stewards on the "*Westernland*" had a clever trick for awakening us in the morning if we showed a tendency to remain late in our berths. They would rush down the passages, shouting at the top of their voices: "Whale! there she spouts!" At this we would jump up wildly, drag on our clothes, and rush madly on deck — to meet a bland "Good-morning" from some one of the officers,— whale nowhere to be seen. On Monday the shouts would be, as I have said, "Whales!" on Tuesday, "Sharks" or "Porpoises!" on Wednesday, "Steamer dead on!" But, as we were fourteen days on the water, their *repertoire* was soon exhausted, as well as their success.

About the twelfth day out, I knew so well what we would have for dinner that I could tell any one of the *menus* for a certainty long before the meal was served. It was very monotonous, for a ten-days' provisioning does not "pan out" very well for a fourteen-days' voyage. At last we sighted land. Ah! the excitement of that moment! I shall never forget it, nor the taking aboard of the pilot, who put his right leg over the railing first, of course, because I had bet that he would put the other.

How strange and interesting that faint little streak of foreign land looked to me as I traced it first away off on the horizon! But it rapidly grew plainer and plainer as we steamed on, until we sighted the Lizard, and felt that we were indeed at our journey's end. Soon after, crowds of fishing-smacks sailed around us. How quaint these staunch litttle craft looked! We were then in the English Channel, and the water had changed from a dark green color to a chalky brown. The shores of France were close upon our right hand, and I gazed upon them with the greatest ecstasy.

After some hours we reached the mouth of the Scheldt, where we came to anchor opposite Flushing. I looked and wondered at everything, at the strong dykes along the shores of the river; at the low, flat country beyond, which seemed to be on an exact level with the sea. We had arrived at the mouth of the river at dusk, too late to make the trip to Antwerp that night, so we stayed there at anchor,

close to the land. Everything was covered with snow, and when the moon rose, its light was reflected back from the white thatched roofs of the quaint little houses, until they were transformed into glistening silver. There before my eyes I saw at last the real Dutch windmill, — how strange and unique the whole scene was! If any one wishes to get a first impression of Old Europe that is especially quaint and curious, let him land at Antwerp.

We sat out on deck that evening, watching the beautiful sight, each one a little sad, as we realized the voyage was over and we might never meet again. We had made strong friendships on board the "*Westernland*," and I know that to two of our party at least, the parting was the cause of real pain. I don't think the reporter cared much, however, as he tried his best to get off the ship and go up to Antwerp by rail. He was "five days late there already" he said, but the captain told him it was impossible, so he was perforce obliged to remain on board a little longer.

We three architects took our tender leave that evening from the fair friends we had made on the voyage. This time we didn't "pitch up" for first chance, but each told his little tale of regret and hope as he found the opportunity. Then the ladies retired, but we fellows sat up on the deck, smoking our pipes, and scarcely exchanging a word, until very late in the night.

The next morning, with our luggage packed and ready to be taken off from the ship, we were all up early to watch the ascent of the river. The Scheldt twists and turns in every conceivable direction, and it is no light task to navigate a great steamer up the narrow channel. She had to be constantly turned about, backed, and started on again, in order to accommodate her length to the various bends in the stream without going through a dyke or two, or committing other damage. The whole scene was strange and interesting to me. We were often near enough to the banks of the river, which were bordered with little low, thatched huts, to halloo to the peasants who stood on the dykes waving their visored caps at us. We could even distinguish their faces, and notice their peculiar dress and great wooden *sabots*. It is here particularly that one sees the real Dutch peasant, whose striking costume differs greatly from that seen in the cities.

Before long we came in sight of the great city of Antwerp dominated by the tall spire of its cathedral, high upon which is a great clock-face. When we reached the dock, crowds of people were there awaiting the arrival of the ship, and I saw then my first foreign soldier, and my first custom-house officer, with his resplendent uniform.

The landing was soon over. Farewells were softly said, adieus were waved to the captain and officers, last looks bestowed upon our noble, salt-covered ship, and our little knot of newly-formed friends was untied. We three architects went together to the Hôtel de la Paix, but the rest of the passengers left Antwerp that night for other destinations, as the undue length of the voyage compelled them to hurry their movements. After being comfortably installed in our rooms at our hotel, we indulged in the first "square meal" that we had had for a fortnight; which gave us an opportunity for airing some very bad French, and also for talking over at our leisure our past experiences and future plans.

We had arrived in Antwerp on the first of January, and we realized our good luck when we were told that this day was celebrated as one of the greatest festivals of the year. Accordingly, feeling much better after our dinner, and wishing to have one more "good time" before we went our different ways, we decided to go to the great annual smoking-concert and masked ball, which took place this night at the Opera-house.

This was a sight worth seeing. There was a variety show first, the actors in which were all either French, or Americans, the latter appearing on the bills as "les petits Washingtons." When the ball was opened and masses of white-robed figures thronged the floor, walking, dancing, or coyly fleeing from their pursuers, we took seats in the gallery which ran the entire length of the house, and leaned over the railing to watch the proceedings below us, being invited from time to time to join the dance. This dance was the "Flemish waltz," which was like dancing on stilts, although it looked easy enough to learn: the men held their partners at arms' length, and went silently "stilting" around and around, always in the same direction, never reversing.

We were presently besieged by a crowd of robed-figures — whether male or female it was impossible to tell — and informed in French that on this night it was not "etiquette" to refuse to dance. So, calling to the other fellows to "whoop it up," I seized the white mass that looked the most feminine, and plunged into the dance. I stilted on bravely until my head reeled, and things about me manifested an unwonted circularity. Then I was supported to my seat and endeavored to talk German and Flemish to my partner, but as my knowledge of either language was extremely limited; I could do nothing better than ejaculate at intervals, "*Dŭ bist verüeht, mein kind, dŭ mŭsst nach Berlin*," or "*zwei bier*." I could not carry on a very extended conversation, naturally, with this vocabulary, but I did better in French. My companions evidently were in the same fix. I could see them panting in different parts of the room, having tried the waltz, and making now the most extraordinary gestures and grimaces as they conversed with their foreign and unknown partners. At twelve o'clock, amidst a most tremendous crash of music, all ranks were levelled, according to old custom. Rag-pickers became the equals of princes, and boot-blacks might kiss queens. Although I was neither queen nor boot-black, I did not escape, nor did my friends, the salutation of many excited, white-robed figures, all of whom we dearly hoped were queens. This wholesale osculation is by no means restricted to the fair sex, as their sterner opposites passionately embrace their brothers at this annual festival. Finally we got together and escaped to our hotel, passing on the way crowds of masquers walking with linked arms, all singing at the top of their voices the then popular "Boulanger March."

Having recovered, the next day, from all the effects of the ball the night before, we sketched some quaint old Dutch gables together, bowed in reverence before the shrine of Rubens, admired the grand cathedral and all its beauties, and then took a long farewell from each other. I left that afternoon for Rotterdam in a third-class carriage.

It was misty, but not very cold at first, with very little ice on the canals, but on arriving at Rotterdam it began to grow sensibly colder. By this time, I was becoming used to the bothersome assiduity of the guides at all corners; so upon arriving, I calmly ignored the vociferations of the excited crowd about me, and as I knew nothing of the way to my hotel, I stood with my luggage between my feet for safe-keeping quietly surveying the mob, until I had picked out the oldest and least anxious one among them, to pilot me to my destination.

[To be continued.]

THE ILLUSTRATIONS

[*Contributors are requested to send with their drawings full and adequate descriptions of the buildings, including a statement of cost.*]

DOORWAY TO HOUSE OF DR. F. C. SHATTUCK, MARLBOROUGH ST., BOSTON, MASS.

[Gelatine Print, issued only with the Imperial Edition.]

TOMB FOR AN ILLUSTRIOUS ARCHITECT DESIGNED BY MR. JULIUS HARDER, NEW YORK, N. Y.

THIS design was awarded an honorable mention in a competition held by the Architectural League of New York.

THE WILLIAMS INSTITUTE, NEW HAVEN, CONN. MESSRS. SHEPLEY, RUTAN & COOLIDGE, ARCHITECTS, BOSTON, MASS.

DESIGNS FOR A COAL OFFICE SUBMITTED IN A COMPETITION OF THE ROCHESTER SKETCH-CLUB BY MESSRS. W. H. ORCHARD, C. F. BRAGDON AND E. S. GORDON.

DESIGNS FOR A GATE-LODGE SUBMITTED IN A COMPETITION OF THE BOSTON ARCHITECTURAL CLUB BY MESSRS. T. F. WALSH AND W. T. PARTRIDGE.

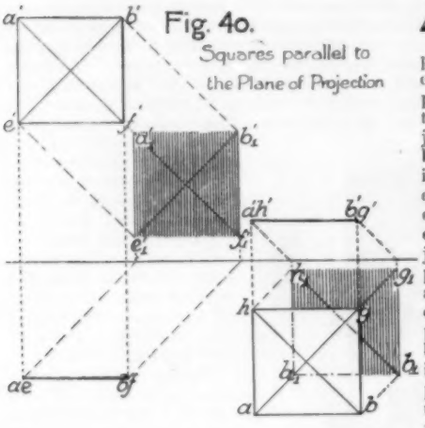
DESIGN FOR A CLOCK TOWER SUBMITTED IN A COMPETITION OF THE T-SQUARE CLUB OF PHILADELPHIA, PA., BY MR. FRANK A. HAYS, PHILADELPHIA, PA.

HOUSE ON FIFTH AVENUE, NEW YORK. MR. W. H. BEERS, ARCHITECT, NEW YORK, N. Y.

ARCHITECTURAL SHADES AND SHADOWS.[1]—V.

CHAPTER V.

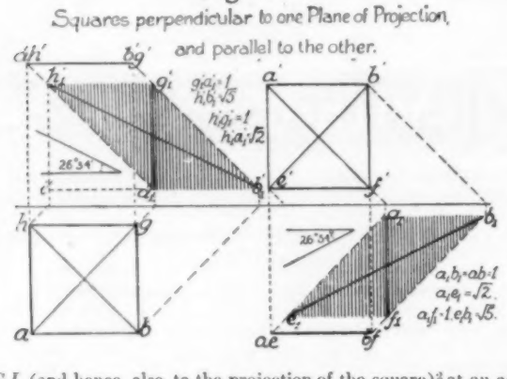
Methods and rules for drawing the shadows cast upon planes of projection by figures composed of principal lines and principal diagonals; discussion of the square, "lozenge," and octagon; their shadows and diagonals; the circle and its shadow; length and inclination of the axes of the ellipse of shadow; drawing the shadows of solids without knowing their lines of shade; notes on the octagon, shadow of circle and ellipse.



46. A square bounded by principal lines must occupy one of three positions relatively to a plane of projection. It may be (*a*) parallel to it, and, consequently, perpendicular to the other plane of projection; (*b*) perpendicular to it, and parallel to the other plane; or (*c*) perpendicular to both. Its shadow in each of these positions, cast upon the plane of projection or a plane parallel to the latter, may be stated as follows, the length of the side of the square being taken as unity:

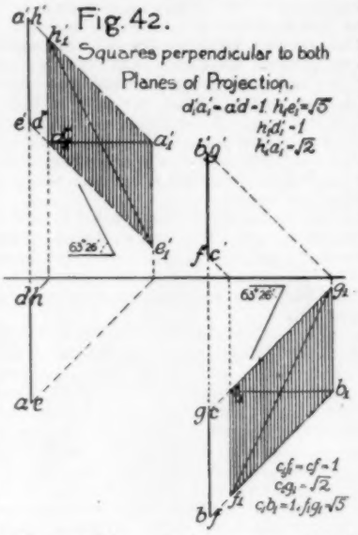
a. Square parallel to a plane of projection. Its shadow is a square equal and parallel to itself; and the shadows of its diagonals (in other words, the diagonals of its shadow) are equal and parallel to the diagonals themselves (Figure 40).

b. Square perpendicular to one plane of projection and parallel to the other. Its projection on the former plane is a horizontal line; its shadow a parallelogram bounded by two horizontal sides equal to the sides of the square (i. *e.*, to 1), and by two lines at 45° to *G L*, shadows of sides normal to the plane of projection, and equal to the diagonal of the square, or $\sqrt{2}$. Of the shadows of its diagonals, one is a vertical line, whose length is 1, and the other a line inclined



to *G L* (and hence, also, to the projection of the square)[2] at an angle whose tangent is ½, or 26° 33′ 54″. The length of this diagonal (as $h'_1b'_1$, Figure 41) is equal to $\sqrt{5}$; for evidently $h'_1b'_1$ is equal to $\sqrt{(b'_1i')^2+(h'_1i')^2}=\sqrt{1^2+2^2}=\sqrt{5}$, because $b'_1i'=2a'_1b'_1=2$. The vertical height of the shadow is 1, and its extreme length 2. These relations are shown in Figure 41.

c. Square perpendicular to both planes of projection. Its projection on either is a vertical line, and its shadow a parallelogram bounded by two vertical sides equal to the side of the square or to 1, and two at 45° to *G L*, shadows of the sides normal to the plane of projection, and equal in length to a diagonal of the square or $\sqrt{2}$. Of the shadows of its diagonals, one is horizontal and equal to 1, and the other is inclined to *G L* at the angle whose tangent is 2, or 63° 26′ 4″, its length being $\sqrt{5}$. Its inclination to the projection of the square is evidently the complement of 63° 26′ 4″, or 26° 33′ 56″. The horizontal width of the whole shadow is 1, and its extreme height 2 (Figure 42).



47. The first case, *a*, falls under Rule (II); *b* and *c* may be included under one rule, being in reality only variations of the same case, which may be thus stated, the shadow being supposed to fall on the plane of projection itself, as explained in 37.

(*IV*) *The shadow cast upon a plane of projection by a square composed of principal lines, and perpendicular to one or both planes of projection, is a parallelogram bounded by two sides equal and parallel to the projection of the square, and by two sides inclined at 45° to G L, and equal to the diagonals of the square. Of the shadows of these diagonals, one is equal and perpendicular to the projection of the square; the other is inclined at an angle of 26° 34′ to the projection of the square, and is equal to* $\sqrt{5}$.

In *b* and *c* alike, one extreme dimension of the shadow is 1 and the other 2; it is composed of two half-squares, and its area is equal to that of the square itself.

48. The dimensions and direction of the shadows of the six principal diagonal lines have been given as a part of the discussion of the square in 46. They are separately shown in the annexed figure, where the letters indicate the direction of the lines according to the system used in Figures 30 and 31. These lines are sufficiently important to warrant the separate enunciation of the length and direction of their shadows in the following rule:

(*V*) *a. Principal diagonal lines parallel to the plane of projection cast shadows upon that plane equal and parallel to themselves.*

b. The projection upon one plane of projection of a principal diagonal parallel to the other plane is a horizontal line. When the right-hand end of the diagonal is the one nearest the former plane its shadow upon it is a vertical line, equal to the projection of the line itself. When its left-hand end is the one nearest the same plane its shadow is inclined at 26° (nearly) to G L, its left-hand end being farthest from G L. Its length is equal to $\sqrt{5}$, *the* projection *of the line being taken as unity.*

c. The projection upon either plane of a principal diagonal lying in a plane normal to both is a vertical line. When the lower end of the diagonal is the one nearest to V′P, the shadow upon either plane is a horizontal line equal to the projection of the diagonal itself. When the upper end is the one nearest to V′P, its shadow upon either plane is a line at 63° (nearly) to G L, the left-hand end being the farthest from G L, and its length is $\sqrt{5}$, *the projection of the diagonal being taken as unity.*[3]

49. *The Lozenge.* This is the square set cornerwise. When bounded by principal diagonal lines, its diagonals are parallel to the sides, and its sides to the diagonals of the "principal" square in corresponding positions. Its shadow may be drawn by casting the shadows of its diagonals (the latter being principal lines) and connecting their extremities. The lozenge bounded by principal diagonal lines may occupy either of three positions relatively to a plane of projection: it may be (*a*) parallel to it; (*b*) perpendicular to it and parallel to the other plane; or (*c*) perpendicular to both. In the last two cases its projection is a straight line, parallel to *G L* in the former, and normal to *G L* in the latter. As in the case of the square these two positions were included under one rule, they will in this case be treated together, the side of the lozenge being taken as unity. Its rectilinear projection must, therefore, be equal to $\sqrt{2}$.

50. *a. Lozenge parallel to plane of projection.* Its shadow is a lozenge equal and parallel to itself, and its diagonals cast shadows equal and parallel *to* themselves, according to Rule (II).

(*VI*) *b and c. Lozenge perpendicular to one or both planes of projection. Its shadow upon the plane to which it is perpendicular is a parallelogram bounded by two sides perpendicular to the projection of the lozenge, and equal in length to half that projection or to* $\sqrt{\frac{1}{2}}$

[1] By A. D. F. Hamlin, Instructor in Architecture in the School of Mines, Columbia College. Continued from page 222, No. 698.

NOTE.—[In view of the inconvenience of having to refer to back-numbers for explanations of the notation used in these papers, the following memorandum will be found of service.]

H P = horizontal plane of projection; *V′ P* = vertical plane of projection; *G L* = ground-line or horizon. Capital letters designate points and lines in space, small italics their horizontal projections, and the same accented or "primed," their vertical projections. Subscript figures indicate points of shadow; small figures above the line indicate points of shade. Greek letters (α, β, γ, θ, δ,) designate angles. The *diagonal* of a line or dimension is its length multiplied by $\sqrt{2}$.

[2] There are, of course, two projections of the square. But in these discussions the projection referred to, unless otherwise specified, is always the one upon the plane which receives the shadow, whichever that may be in any particular case.

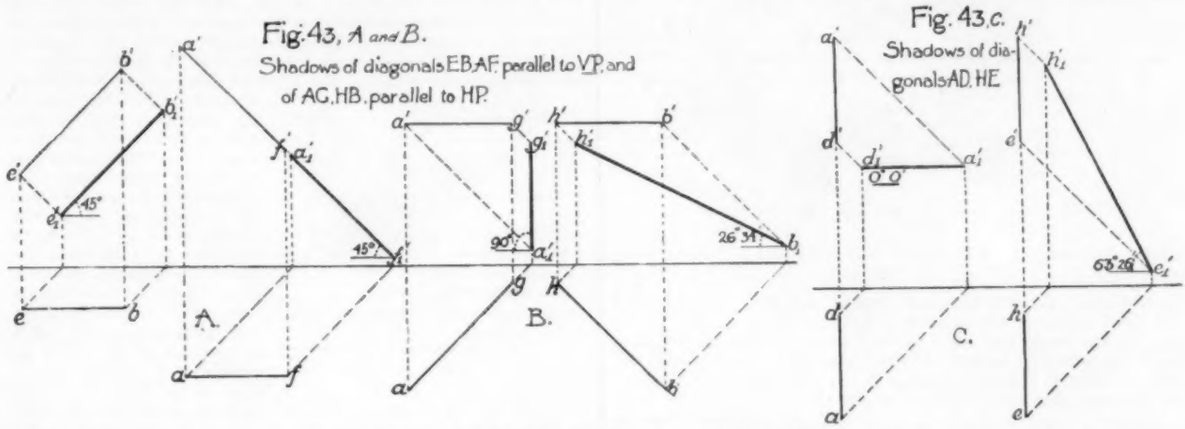
[3] If the length of the diagonal itself be taken as unity the length of its shadow in *b* and *c* is found by multiplying the length given in the Rule by $\sqrt{2}$.

and by two sides inclined at an angle of 26° 34′ *to the projection of the lozenge, and whose length is* $\sqrt{\frac{1}{2}}$. *Of the shadows of its diagonals, one is equal and parallel to the projection of the lozenge, its length being, therefore,* $\sqrt{2}$; *the other is inclined at* 45° *to G L, and is equal to* 2.

The extreme height and width of the shadow of the lozenge are each equal to the length of its rectilinear projection, and hence to the length of its diagonals, or $\sqrt{2}$. Inspection of the figure shows the fact, easily demonstrated by plane geometry, that the area of the shadow equals one-half the square constructed upon the projection or diagonal of the lozenge. Since this square must equal $\sqrt{2}^2$ or 2, the area of the shadow is 1, and is, therefore, equal to that of the lozenge itself, as the analogy of the square would lead us to expect.

51. *The Octagon.* This occurs so frequently in architectural forms that its geometric relations deserve careful attention. They also because in a large proportion of the cases occurring in practise, it enables us to cast the shadows on an elevation without having to refer to the plan, and *vice versâ;* while in many other cases it is only necessary to refer to the plan for the determination of a single point or dimension of the shadow on the elevation, all the others being easily derived from the latter by the rules. The same method of statement will be followed in all cases where the form and dimensions of a figure, plane or solid, can be ascertained from one projection without referring to the other. The explanatory figures in the text will show both projections of the figure and of the rays passing through its principal points, thus enabling the reader to verify by inspection the statements made in the discussion and in the rules; but the practical application of the latter will make evident the saving of labor effected by dispensing in each case with one of the two projections of the figure casting the shadow.

The reader is further reminded of the simplification of statement mentioned in 37[1], and again in 47, which results from supposing the shadows to fall upon the plane of projection. As a matter of fact,



will be briefly explained in a note to this chapter, with hints for its easy and correct construction. It appears wholly or in part as the basis of the forms of pavilions, bay-windows, oriels, turrets and towers, and in the plans and sections of many minor objects like newels, piers, chamfered posts, etc. As it commonly occurs with its sides alternately in the position of principal lines and of principal diagonals, and, as furthermore, it furnishes the most convenient means of drawing the shadow of the circle, it is proper to note with care the form and properties of its shadow. This the student is advised to construct in the three positions corresponding to *a*, *b* and *c* in 46 and 50, by means of the rules given for shadows of principal

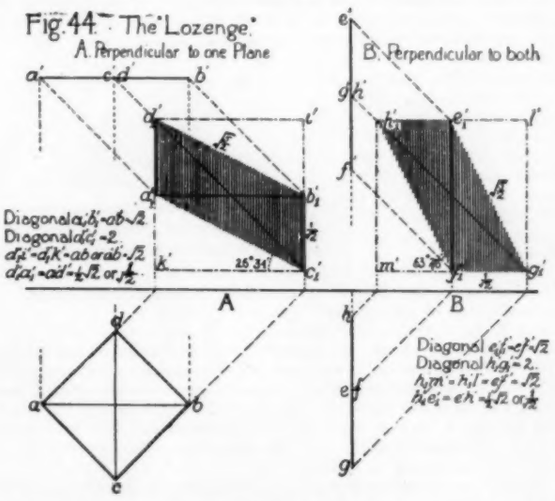


Fig. 44. The Lozenge.
A. Perpendicular to one Plane
B. Perpendicular to both
Diagonal a'b' = ab √2
Diagonal d'c' = 2
d'x' = d'k' = ab or ab √2
d'a' = ad = ½ √2 or ½
25° 34′
A
B
Diagonal e'f' = ef √2
Diagonal h'g' = 2
h'm' = h'l' = e'f' = √2
h'e' = eh = ½ √2 or ½

and diagonal lines, as well as by direct projection of points. The following discussion will be thereby rendered clearer, and its statements easier to remember.

52. In dealing with the line normal to a plane of projection, with the square, and with the lozenge, the rules for drawing the shadows have all been so expressed as to apply in each case equally to either plane of projection without reference to the other. That is to say, the shadow can in each case be constructed by means of one projection alone of the figure, provided only its distance from the plane of incidence be known; and where this is not known, it is the only fact or dimension for ascertaining which the other projection of the figure is required. This method of stating the rules will, therefore, be found convenient not only because of its comprehensiveness, but in any one drawing they may fall on a great variety of planes, of which, however, a large part are parallel to the vertical or to the horizontal plane of projection. But the plane of projection may be arbitrarily assumed to coincide with each of these planes in turn, the trace of the plane of incidence serving as the new ground-line, since the projections of an object are not altered by moving the vertical plane of projection forwards or backwards, nor by raising or lowering the horizontal plane. A vertical wall parallel to the picture-plane is represented in plan by a horizontal line, which may be used as the ground-line in finding the shadows cast upon that wall. Similarly any horizontal plane receiving a shadow may be taken as *H P*, the horizontal line which is its vertical trace, and which represents it in elevation, being used as the new ground-line, whatever its actual height. This statement of an obvious fact will assist the beginner in tracing out the shadows on the various surfaces of the steps and door in Plate II, No. 5, and the window No. 11, besides avoiding the useless repetition of the words "or on a plane parallel to the plane of projection." When such planes, parallel to *V P* or *H P* are referred to, they will be called *coördinate planes*, the planes of projection being merely a special case of coördinate planes. Planes perpendicular to both planes of projection will be called *profile* planes.

53. The octagon composed of principal lines and of principal diagonal lines — that is, of lines respectively parallel, perpendicular and inclined at 45°, to one or both planes of projection — may occupy any one of three positions. It may be (*a*) parallel to the plane of projection, in which case its projection is an octagon equal and parallel to itself; or (*b*) perpendicular to one plane and parallel to the other, its projection on the former being a horizontal line; or (*c*) perpendicular to both, in which case its projection on either is a vertical line. In other words, the plane of such an octagon may be either a coördinate plane or a profile plane.

a. Octagon parallel to plane of projection. In this position the shadow of the octagon is an octagon equal and parallel to the octagon itself, side for side, and falling under Rule (II), requires no further discussion.

b. Octagon perpendicular to one and parallel to the other plane of projection. Its shadow upon the former is an irregular octagon inscribed in the shadow of the corresponding square (47, *b*), and is drawn as follows: Construct the shadow of the square whose projection coincides with that of the octagon (Figure 45); draw its vertical diagonal and the rays passing through the two inner projections of corners of the octagon ($c' f'_1 c'_1$ and $b' g'_1 b'_1$, Figure 45, A). Through the intersections of these two rays with the vertical diagonal, draw horizontal lines. The eight intersections of these latter, and of the two rays, with the shadow of the square, mark the eight ngles of the shadow of the octagon, which is thus completely determined. Of its eight sides, two are shadows of the sides of the octagon parallel to the plane of projection, and are, therefore, horizontal lines equal and parallel to those sides, or to 1, if we take

[1] In No. 698 of the *Architect.*

a side of the octagon as unity. Two are shadows of the two sides of the octagon perpendicular to the plane of projection, and are, therefore, inclined at 45° to $G\,L$, and equal to the diagonal of a side of the octagon, or to $\sqrt{2}$. The remaining four sides of the octagon, alternating with the above, are parallel in pairs to the diagonals of the circumscribed square; two of them, therefore, cast short vertical shadows equal to their own projections, or to $\sqrt{\frac{1}{2}}$ or $\frac{1}{2}\sqrt{2}$ ($g'_1 k'_1$, $d'_1 c'_1$, Figure 45, A, and $o_1 n_1$, $i_1 k_1$, *ibid B*), while the other two cast

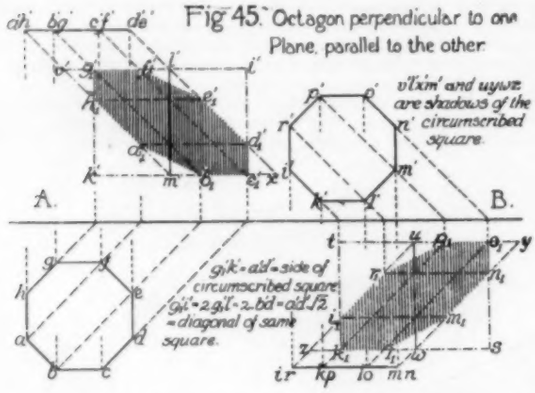
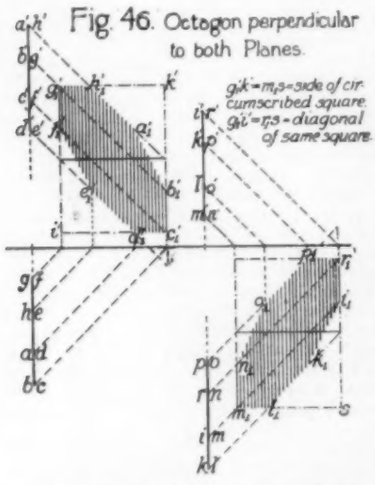


Fig 45. Octagon perpendicular to one Plane, parallel to the other.
v'i'm' and u'y'z' are shadows of the n' circumscribed square.
A.
B.
g₁k' = a'd' = side of circumscribed square.
g'i' = 2 g'l' = 2 bd = a'd'√2 = diagonal of same square.

oblique shadows inclined at 26° 34′ to $G\,L$ (49, and Figure 45, $f'_1 e'_1$, $a'_1 b'_1$ *in A*; $l_1 m_1$, $p_1 r_1$ *in B*). The length of these latter is $\sqrt{\frac{1}{2}}$, the unit being, as above stated, the length of a side of the octagon. The total height of the shadow is equal to the projection of the octagon, and its extreme width to the diagonal of that projection or of the circumscribed square. For in Figure 45 $g'_1 l'$ is evidently half of $g'_1 i'$. But $g'_1 l'$ is also equal to $b'c' + c'a'$, that is, to a side of the octagon, *plus* the projection of an oblique side of the same. Hence (Note A at end of chapter) it is equal to half the diagonal of the square, and $g'_1 i'$ which equals 2 $g'_1 l'$, is equal to the diagonal of the square.[1] The extreme right and left hand angles of the shadow are right-angles.



c. Octagon perpendicular to both planes of projection. The octagon in a profile plane casts on either plane of projection a shadow precisely identical with the preceding, except in the direction of its sides with reference to $G\,L$ (Figure 46). Their direction with reference to the projection of the octagon is unchanged, but the latter is at right-angles with its position in *b*. The extreme width of the shadow of the octagon is now equal to the projection of the latter, and its height to the diagonal of that projection. The shadow may be inscribed in a rectangle of the same dimensions as in the preceding case, but set up on end.

54. The two cases *b* and *c* just discussed, may be included in one rule as follows: *a* falling of course under Rule (II) requires no further discussion.

(*VII*) *The octagon composed of principal lines and principal diagonal lines, and perpendicular to a plane of projection, casts upon that plane a shadow bounded by eight sides. Two of these are parallel to the projection of the octagon and equal to a side of the latter; two are perpendicular to its projection and equal to the projection of an oblique side of the octagon; two are inclined at 45° to G L and equal to the diagonal of a side of the octagon; and the remaining two are inclined at 26½° to its projection and equal to* $\sqrt{\frac{1}{2}}$ *of one of its sides.*

The area of the shadow of the octagon is equal to that of the octagon itself. The length and inclination of the shadows of the various diagonals of the octagon are not matters of special importance; their investigation would lead us too far afield, and the results would have little pertinence to our main object. They are consequently omitted from our discussion.

55. Since a circle inscribed in an octagon is tangent to the middle of each of its sides, the shadow of a circle cast on a plane must be a circle or ellipse tangent to the middle of each side of the shadow of the octagon. The shadow of the circumscribed octagon may therefore be used to obtain eight points of the required ellipse of the circle's shadow, and its direction at each of these points, and these data are quite sufficient to enable the draughtsman to draw the ellipse free-hand with very considerable accuracy (Note C at the end of this chapter). In the three positions corresponding to those of the square or octagon of the preceding paragraphs, the circle casts the shadows described below.

a. Circle parallel to a plane of projection. It casts a shadow on that plane equal and parallel to itself, and the shadow of its centre is the centre of its shadow. It is a case falling under Rule (II).

b. Circle perpendicular to one plane of projection and parallel to the other. In order to draw its shadow on the former, we observe that the projection of the circle is a horizontal line coinciding with that of the circumscribed octagon and square. Constructing the shadow of the octagon, and that of the square with its two diagonals (Figure 47 A, $e'\,g'$ and $f'\,p'$) the intersection of the latter with each other gives us the centre of the required ellipse, while their intersections with four sides of the shadow of the octagon give us the middle points of those sides, namely m', r', n', p', in the same figure. A horizontal line drawn through the centre of the ellipse, and another at 45° to $G\,L$ through the same point, intersect the four other sides of the octagonal shadow in their middle points, k', k', l', i', and we have thus the required eight points of tangency of the ellipse of shadow of the circle; that is, eight points of the curve and its direction at each of them. The ellipse can now be drawn free-hand through these points with an accuracy quite sufficient for ordinary purposes. Indeed, quite ordinary skill in drawing the ellipse enables one to construct the shadow of the circle with reasonable correctness by means of the four points of tangency furnished by the shadow of the square alone; and where extreme precision is not required, the greater simplicity of this method warrants its use in preference to the other (Figure 47 B).

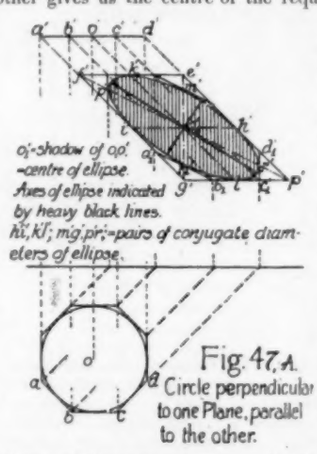

o'₁-shadow of o o'.
-centre of ellipse.
Axes of ellipse indicated by heavy black lines.
k'i', k'l'; m'g', p'r'₁-pairs of conjugate diameters of ellipse.

Fig. 47 A. Circle perpendicular to one Plane, parallel to the other.

56. The length of the axes of this ellipse of shadow, and their respective inclinations to $G\,L$, may be computed by the processes of analytical geometry,[2] or by the differential calculus. The latter is the method employed and demonstrated in Note B, at the end of this chapter. The results obtained by these calculations are given herewith, and should be carefully noted, as they furnish a simple and direct means of constructing these axes in place, and of the right dimensions and inclination, by the operations of plane geometry.

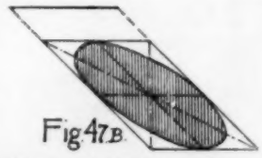


Fig 47 B. *Shadow of circle drawn by means of circumscribed square, without the octagon, and from one projection alone of circle whose distance from plane of incidence is known or assumed.*

Taking the diameter of the circle as unity, the length of the major axis of its shadow is found to be 1.61803, and its inclination to $G\,L$ (and consequently to the projection of the circle), 31° 43′ 3″, which we will call *angle* Θ. The inclination of the minor axis (which we may call Θ′), is of course the complement of this angle, and measures therefore, 58° 16′ 57″. The length of the minor axis is .61803, so that the difference between the two axes is 1. That is, *the diameter of the circle is equal to the difference between the lengths of the axes of its shadow.*

Let us now consider those two diameters of the circle, whose shadows form respectively the major and the minor axis of the ellipse; let us call the former of these diameters M, and the latter N; let a be the angle made by M with the plane of projection, and a' the angle made by N with the same plane. Now since the shadows of M and N are axes, and therefore conjugate diameters of the ellipse, M and N must be conjugate diameters of the circle[3]

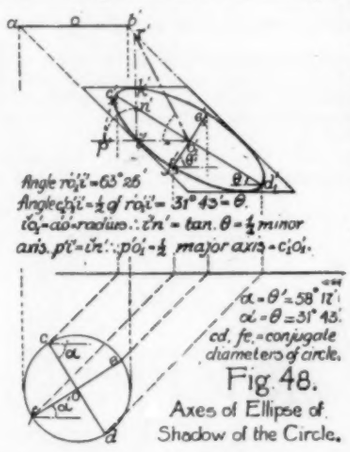
[1] The shadow of the octagon is thus inscribed in the rectangle whose sides are equal to the side and diagonal of the circumscribed square, and two of the diagonally opposite angles of this rectangle coincide with the extreme angles of the shadow. The length of this rectangle may be determined by laying off to right and left of the vertical diagonal $b'm'$, a distance equal to $a'c'$ or $b'd'$, its height being that of the vertical diagonal itself.

[2] This has been admirably done by Mr. William Watson in his ingenious treatise on "Shades and Shadows" (Boston: Cupples, Upham & Co.), in Articles 28 and 30.

[3] Two diameters are said to be conjugate when each is parallel to the tangents at the extremities of the other; and since every tangent to a circle is perpendicular to the diameter terminating in the point of tangency, conjugate diameters of the circle are at right angles to one another. Now the *shadow* of each diameter must be parallel to the *shadow* of the tangent parallel to that diameter (that is, to the tangent to the curve of shadow); hence the shadows of conjugate diameters of the circle are conjugate diameters of the ellipse.

and therefore at right angles with one another. Investigation proves that *the angles a and a′ made by M and N with the plane of projection are the complements respectively of the angles Θ and Θ′ made with G L by the shadows of those diameters.* It further appears that *the tangents of a and a′ are respectively equal in length to half the axes which are the shadows of M and N;* that is, tangent $a = \frac{1}{2}$ major axis, and tangent $a' = \frac{1}{2}$ minor axis, of the ellipse of shadow.

57. The angle a' or Θ^1 is, as above stated, 31° 43′ (disregarding the seconds). This is precisely one-half the angle 63° 26′ made with *G L* by the long diagonal of the square in 46 *c*. The difference numerically in degrees between *a* and *a′*, as between Θ′ and Θ, is 26° 34′, which is the inclination of the long diagonal in 46 *b*. Thus the axes of the shadow of the circle, and the diagonals of the shadows of principal squares appear closely related. The diagonals of the shadow of the circumscribed square are unfortunately of little service in constructing the required axes of the ellipse by plane geometry. But this can be done as shown in Figure 48, by drawing the diagonal of the shadow of the *square at right angles* to the circumscribed square. If having constructed the shadow of the square circumscribing the circle *c e d f*, *a′ o′ b′*, and having found *i′* the middle of one long side, we erect the vertical *i′ k′ r′* till it meets in *r′* the ray passing through *b′*, we have half the shadow of a square perpendicular to the circumscribed square, and *r′ o′*$_1$ is its diagonal, passing through *o′*$_1$ the centre of the ellipse; *r′ o′*$_1$ *i′* is therefore an angle of 63° 26′; bisecting it, we have *n′ o*$_1$*′* making the angle 31° 43′ which gives the *direction* of the required major axis, to which the minor axis is of course perpendicular. But since *i′ o′*$_1$ = radius of the circle, *i′ n′* = tangent of *n′ o*$_1$*′ i′* = tangent of 31° 43°, which equals half the minor axis, as already stated. Revolving *n′* down to *p′* we have *o′*$_1$ *p′* equal to the radius + *i′ n′* or to half the diameter of the circle + half the minor axis, that is, to half the major axis.[2] Therefore *p′* revolved up to *c′*$_1$ gives us *c′*$_1$ *o′*$_1$ = semi-major axis; *o′*$_1$ *d′*$_1$ being made equal to this, completes the major axis, and the minor axis, normal to it, is easily laid off equal to twice *i′ n′*.


Angle r o′₁ i′ = 63° 26′
Angle c′ o′₁ i′ = ½ of r o′₁ i′ = 31° 43′ = Θ.
i′ o′₁ = a o′ = radius. ∴ i′ n′ = tan. Θ = ½ minor axis. p′ i′ = i′ n′ ∴ p′ o′₁ = ½ major axis = c′ o′₁.
α = Θ′ = 58° 17′
α′ = Θ = 31° 43′
cd. fe. = conjugate diameters of circle.
Fig. 48.
Axes of Ellipse of Shadow of the Circle.

The problem is thus solved, really in much less time than is occupied by this description of the solution. Figure 48 makes all this clear; in this figure *c d* is the diameter *M* and *f e* the diameter *N*.

58. While this is a convenient method for drawing the required axes with perfect accuracy, so that one is thereby enabled to construct the ellipse with precision from its axes by any one of several well-known processes, the circumscribed square or octagon will be found to furnish the most practical and convenient method for drawing the ellipse in ordinary cases. There is, however, another method which approximates sufficiently to correctness to be serviceable, while dispensing with the square and octagon. By substituting for the angles 58° 17′ and 31° 43′, the simpler angles of 60° and 30°, we are enabled to lay off the direction of the required axes with the 30° × 60° triangle, while the resulting error is hardly perceptible. And by making $\frac{5}{8}$ and $\frac{3}{8}$ of the diameter of the circle do duty respectively for 1.618 and .618, we can measure off the required length of either axis with the dividers, with great ease. From the axes thus obtained a sufficiently true ellipse can be drawn free-hand by any draughtsman of tolerable skill, or more accurately constructed by the familiar geometric methods.

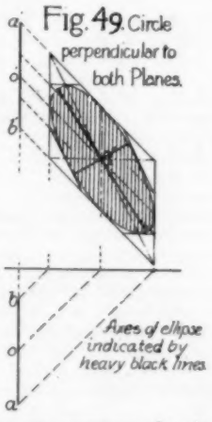


Fig. 49. Circle perpendicular to both Planes.

Fig. 50.

It is evident that the ellipse of shadow of the circle is comprised within the same limits of extreme length and height, as the shadow of the corresponding octagon. It can, therefore, be inscribed in the rectangle whose sides are equal to the diameter of the circle and its diagonal, or to the side and diagonal of the circumscribed square, the points of tangency being very near two diagonally opposite corners of the rectangle.

59. *c. Circle perpendicular to both planes of projection.* The circle in a profile plane casts upon either plane of projection a shadow precisely like the one just described, except in the angle of its inclination to *G L*. As in the case of the octagon, the relation of its various parts to the projection of the figure casting the shadow is unchanged; but that projection being now perpendicular instead of parallel to *G L*, the angles made with the latter are the complements of those in *b*. In this case, therefore, *a* and *a′* become respectively equal, instead of complementary, to Θ and Θ′. If, however, we make Θ and Θ′ represent in both cases the angles of inclination of the axes *to the projection of the circle*, instead of to *G L*, the statements with regard to *a*, *a′*, Θ, and Θ′ in *b* become true of the present case also. The major axis of the ellipse in the case under consideration makes an angle of 58° 16′ 57″ with *G L*, but its inclination to the projection of the circle remains as before, 31° 43′ 3″; the inclination of the minor axis to *G L* is 31° 43′ 3″; but to the projection of the circle its inclination is 58° 16′ 57″, as in *b*.

60. The two cases, *b* and *c*, may be included, therefore, under one rule, as follows (round numbers being substituted for precise figures):

(*VIII*) *The shadow of a circle perpendicular to a plane of projection is an ellipse inscribed in the shadow of the circumscribed octagon, and tangent to the middle of each side of that shadow. Its major axis is inclined to the projection of the circle at an angle of* 30° *very nearly, its length being in round numbers* $\frac{5}{8}$, *and that of the minor axis* $\frac{3}{8}$ *of the diameter of the circle. The centre of the ellipse is the shadow of the centre of the circle, and the areas of the circle and of its shadow are equal.*

61. The four diameters of the circle which are respectively parallel and perpendicular to the plane of projection, and inclined to it at 45° in either direction, deserve a moment's attention. Their shadows pass through the centre of the ellipse (55, *b*), and terminate in the eight points where the ellipse is tangent to the shadow of the octagon. The extremities of the two "diagonal" diameters of the circle (that is, of diameters at 45° to the plane of projection) have been called by a happy inspiration of Prof. W. R. Ware's the "corners" of the circle (Figure 50). They are important points, marking the two points of tangency of rays of light, the point of greatest illumination, and the central point of shade on the circumference of the circle. In the case of a right cylinder perpendicular or parallel to one or both planes of projection, the two points of tangency of rays of light mark the ends of the straight lines of shade on the surface of the cylinder, these lines being said to be on the "corners" of the cylinder (Figure 53).

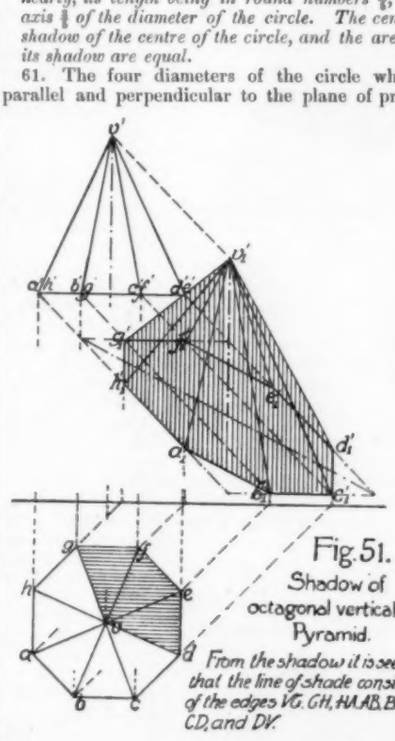


Fig. 51.
Shadow of octagonal vertical Pyramid.

62. Having mastered the cases of lines at 0°, 45° and 90° to one or both planes of projection, which cast their shadows on coördinate planes, together with the plane figures composed of such lines, it becomes possible to draw the shadow of any solid composed of these lines and figures when cast upon a plane of projection or coördinate plane. The chief difference between plane and solid figures relates to the line of shade, which, in the case of plane figures, is nothing else than the outline of the figure itself, and presents no difficulty whatever. But every solid has its own definite line of shade, whose shadow is the outline of shadow of the solid, but whose actual form and horizontal and vertical projections are often not evident at a

[1] In the preceding discussion of these angles no account has been taken of + and − signs of tangents and angles, nor of their *algebraic* value. The angles have consequently not been read always in the same direction, the *acute* angle being taken in each case for measurement. This is less rigidly scientific, perhaps, but more practical than the other course, because architectural draughtsmen prefer to construct and to specify obtuse angles by means of their complements.

[2] Because the minor axis + diameter of the circle = major axis, as stated in 56.

glance. In order, therefore, to draw correctly the shadow of such a solid, it would appear necessary to first ascertain its line of shade. In many cases, however, this necessity is only apparent; for if, disregarding the line of shade, we cast the shadows of all the faces and edges of the solid, the shadows of those edges which are not lines of shade will fall within the limits of the whole shadow, whose extreme outline will be the shadow of the line of shade. In Plate II,[1] No. 3, for example, the shadows of all twelve edges of the vertical tile are cast. The shadows of six of these edges which form an irregular hexagonal outline, while those of the other six fall wholly within this outline. The former six, therefore, form the line of shade; namely, $d'e'$, $e'f'$, $f'b'$, $b'g'$, $g'k'$ and $k'd'$. The same thing is seen in No. 4. Thus it is possible to work backwards, and to ascertain the line of shade of a solid by means of the shadows of all its parts. But this is an exceptional procedure; it requires the casting of a number of shadows, which, in the end, prove wholly superfluous, and is less direct and less scientific than to cast the shadow from the line of shade. In some cases, however, it is so difficult, if not impossible, to ascertain directly the projections of the latter, that the procedure above suggested becomes at once the easiest and most direct solution of the problem, as in the case of the cone; and there are other occasions in which the draughtsman finds it to his advantage to operate backwards in the above manner. The shadow of the octagonal tile (No. 7 in Plate II) is obtained in this way, and the student will find no difficulty in finding its line of shade from this shadow. In the same way, he may find the shadows on coördinate planes and the lines of shade of a variety of rectangular and octagonal parallelopipeds and prisms. By casting the shadow of the base of a pyramid and connecting its extreme points with the shadow of its apex, the shadow of that solid may be drawn and its line of shade ascertained (Figure 51). In the same way, two lines drawn from the shadow of the apex of a cone tangent to the elliptical shadow of its base complete the shadow of the cone itself. By tracing the rays from the two points of tangency back to the projections of the base of the cone itself we obtain the projections of one end of each of the straight portions of its line of shade, which can then be drawn from these points to the apex of the cone, this being the *only* way to find the line of shade on a cone (Figure 52).[2] The same process may be applied to the cylinder, whose shadow is cast by drawing the shadows of both of its bases and connecting them by two parallel tangents, which are, of course, the shadows of the rectilinear parts of its line of shade. The latter can be found, as on the cone, by following back to the cylinder the rays passing through the points of tangency of the shadow; and they prove to be, as stated in 60, on the "corners" of the cylinder in the case of all such as have axes parallel or normal to the plane of projection (Figure 53). But this is only an alternative method in the case of the cylinder and of most geometrical solids, whose lines of shade, as well as the forms of their shadows, can be brought under general rules or specific statements. This will be done in the next chapter for the cube and parallelopiped, the octagonal prism, the square and octagonal pyramid, the cylinder and the cone. The student will in the meanwhile find it both profitable and interesting to cast the shadows of these solids by the method just indicated, and to find the form and nature of their lines of shade in those positions in which they most frequently occur in architectural practice. He will, as a result, find himself on familiar ground when the discussions of the next chapter are reached. Even the sphere may be treated in this manner by casting the shadows of its three "principal" great circles (59, VIII) and drawing the circumscribed ellipse tangent to the three shadows.

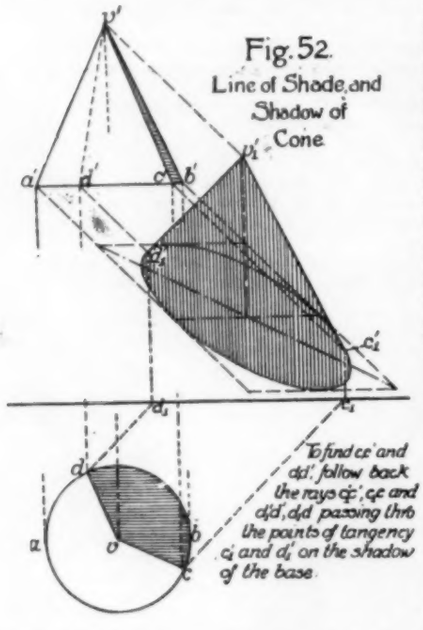
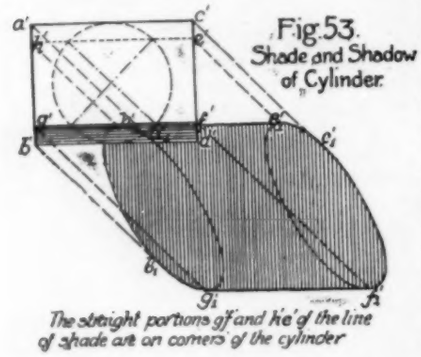
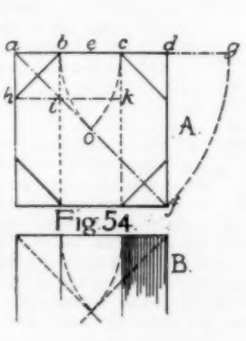
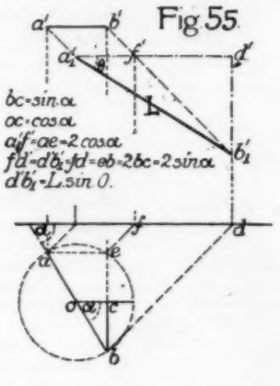


Fig. 52.
Line of Shade and Shadow of Cone
To find $c_1 c'$ and $d_1 d'$, follow back the rays $c'c$, $c_1 c$ and $d'd$, $d_1 d$ passing thro the points of tangency c_1 and d_1 on the shadow of the base.



Note A. The regular octagon may be drawn either (*a*) by means of the inscribed circle, to which with the T-square and 45° triangle the eight sides are drawn tangent: or (*b*) by revolving down upon the sides of a square its half-diagonals as in Figure 5, A. This latter method is specially convenient when only the rectilinear projection of the octagon is desired, as it locates at once the two interior angles (Figure 5, B). Two points thus obtained suffice, indeed, for drawing the whole octagon, since parallels to the adjacent sides of the square drawn through these points, locate on the opposite side the ends of the other two oblique sides of the octagon. The length of any side of the octagon is the diagonal of the projection of an oblique side: hence if that length be taken as unity, the length of the projection $a\,b$ of an oblique side $h\,b$ is $\frac{1}{2}\sqrt{2}$ or $\frac{1}{\sqrt{2}}$. The difference between the length of the side and diagonal of the circumscribed square equals a side of the octagon; thus (Figure 5, A) $ag - ad = bc$ or 1. This suggests another method of drawing the octagon, which may be left to the reader's ingenuity to work out. In order to demonstrate these statements, it is required to prove that the half-diagonal $ao = bc + ab$, and that af (or ag) $= ad = bc$, that is, that $dg = bc$. Now $ao = ai + io$. But $ai = hb = bc$. And $io = ab$, since their diagonals ik and kb both $= bc$.





Hence $a\,o$, since it equals $ai + io$, must equal $bc + ab$, q. e. d. Furthermore, $ac - ae = ec$. Multiplying by 2, and remembering that $2\,ac = 2\,ao = af = ag$; that $2\,ae = ad$, and that $2\,ec = bc$, we have $ag - ad = bc$, q. e. d.

Note B. *Axes of the ellipse of shadow of the circle.* Plane geometry furnishes a method for mechanically delineating the axes of any ellipse of wh ch two conjugate diameters are given. This applies to the ellipse inscribed in the shadow of the octagon, since any two alternate diameters of the four passing through the eight points of tangency, are conjugate diameters. But this method is not simple or direct enough to be of practical service to the draughtsman, and is, therefore, omitted fro.a our discussion. In order to deduce a general statement of the relations between the diameters of the circle and the axes of its shadow, and to demonstrate these relations the processes of analytical geometry may be employed, as has been done by Mr. W. Watson in his "*Shades and Shadows*," referred to in the note to 56. Another treatment of the subject is herewith presented, based on the principle of maxima and minima as developed in the differential calculus, and readers of a mathematical turn-of-mind may be interested to follow out the operations and reasoning involved:

Taking for illustration the horizontal circle casting its shadow on $V'P$ (Figure 55) the line L is seen to be the shadow of a diameter $a\,b$, $a'b'$, of a circle; α is the angle which this diameter (which we will call M) makes with $V'P$, and Θ the angle made by L with $a'b'$ or GL. Now $L^2 = (a'_1 d')^2 + (d' b'_1)^2 = (M.\ \cos.\ \alpha + M.\ \sin.\ \alpha)^2 + (M.\ \sin.\ \alpha)^2 = M.^2 \cos.^2\alpha + 2\ M.^2\ \cos.\ \alpha.\ \sin.\ \alpha + M^2\ \sin^2\alpha \times M^2\ \sin.^2\alpha = M^2\ (\cos.^2\alpha + 2\ \cos.\ \alpha.\ \sin.\ \alpha + 2\ \sin.^2\alpha)$; and since $\cos^2 + \sin^2 = 1$, and $M = 2$ (being twice the radius which is the unit in Trigonometry) $L^2 = 4\ (1 + \cos.^2\alpha + 2\ \cos.\ \alpha.\ \sin.\ \alpha + \sin.^2\alpha)$ whence

$$L = 2\sqrt{1 + 2\ \cos.\ \alpha\ \sin.\ \alpha + 2\ \sin.\ \alpha} \quad . \quad . \quad (1)$$

Now the major axis of the ellipse is the longest shadow that can be cast by a diameter of the circle; hence the value of α which makes L a maximum will be the angle of inclination to $V'P$ of the

[1] See No. 698, issue of May 11.

[2] What appear to be other methods are in reality variations or abridgements of this one.

diameter whose shadow is the major axis of the ellipse. Differentiating, we have

$$\frac{dL}{d\,a} = 2\cos^2 a - 2\sin^2 a + 2\sin a \cos a \quad . \quad . \quad (2)$$

and since for the maximum value, $\frac{dL}{d\,a} = O$, we obtain by dividing by 2 cos.^{2} a, and transposing

$$\frac{\sin.^2 a}{\cos.^2 a} - \frac{\sin. a}{\cos. a} = 1\text{; that is, tan.}^2 a - \text{tan. } a = 1 \quad . \quad (3)$$

Completing the square and extracting the roots of the equation, tan.^{2} a — tan. $a + \frac{1}{4} = 1\frac{1}{4}$, and tan. $a - \frac{1}{2} = \pm\frac{\sqrt{5}}{2}$, whence

$$\text{tan. } a = .5 \pm \sqrt{\tfrac{5}{4}} = 1.61803 \text{ or } -.61803 \quad . \quad . \quad (4)$$

That is, in order that M may cast its longest shadow, which is the major axis of the ellipse, it must make with $V'P$ the angle whose tangent is 1.61803, namely, 58° 16′ 57″; and the conjugate diameter which casts the shortest shadow, must have the inclination whose tangent is —.61803, or — 31° 43′ 3″, since this makes L a minimum. This latter angle proves to be, as it should be, the complement of .

To find the values of L, substituting in (1) the values of sin. a and cos. a corresponding to 58° 16′ 57″, we have $L = 2$ (1.61803); while for the angle — 31° 43′ 3″, we obtain the minimum value 2 (.61803) values exactly equal to twice the *tangents of these two angles*. The value of Θ is obtained from the proportion sin. Θ : b', d' : : radius : L, whence $\frac{\text{sin. } \Theta}{2 \text{ sin. } a} = \frac{1}{L}$ Therefore sin. $\Theta = \frac{2 \text{ sin. } a}{L}$, and substituting in this equation the ascertained values of sin. a and L, we find that $\Theta =$ the angle whose sine is .525813 = 31° 43′ 3″. The minor axis at right angles to this must, therefore, be inclined at 58° 16′ 57″ to the vertical projection of the circle or to $G\,L$. *Hence the angle of inclination of either axis of the ellipse is the complement of the inclination to the plane of projection of the diameter whose shadow is that axis.*

The same result is reached by noting that cos. $\Theta = \frac{a'_1\ a'}{L} = \frac{2(\text{cos. } a + \text{sin. } a)}{L}$ and tan. $\Theta = \frac{\text{sin. } \Theta}{\text{cos. } \Theta} = \frac{2 \text{ sin. } a}{L} \div \frac{2(\text{cos. } a + \text{sin. } a)}{L}$ $= \frac{\text{sin. } a}{\text{cos. } a + \text{sin. } a}$. Hence

$$\frac{1}{\text{tan. } \Theta} = \text{cot. } \Theta = \frac{\text{cos. } a + \text{sin. } a}{\text{sin } a} = \text{cot. } a + 1. \quad . \quad (5)$$

But from (3) we have (dividing by tan. a), tan. $a - 1 = \frac{1}{\text{tan } a}$, or in other words, tan. a = cot. $a + 1$, which (5) shows to be equal to cot. Θ. That is, a *and* Θ *are complementary angles*, since cot. Θ = tan. a. Q. E. D.

NOTE C. *The ellipse.* The subtle beauty and peculiar character of this curve every draughtsman should thoroughly understand, and be able to reproduce with ease and accuracy for any given axes. Its constant occurrence in the projection and perspective of arches and circles, and its own intrinsic grace of movement, demand this; but there are few architectural forms more often incorrectly and unsympathetically drawn. Its beauty and subtilty lie in its gradual but regularly increasing change of curvature. The circle is an easier curve to understand, but harder to draw well, because the least error is evident to the eye and spoils its beauty, while slight variations from accuracy in the ellipse are not so noticeable or offensive. It is a good plan to execute, free-hand, some of the geometrical methods for constructing the ellipse on given axes, and then to sketch the same ellipses off-hand, observing carefully the rate of curvature, especially near the vertices. The change of rate should never be sudden nor specially marked at any one point. Practice in drawing ellipses of very varied proportions, making them always so perfect as to *appear like the perspectives of circles*, is never wasted, since the training it gives to hand, eye, and the artistic perceptions, is of the most excellent sort.

[To be continued.]

ROMAN RUINS IN ALGERIA.

Waterspout from Dantzic

BATNA, whose Arabic equivalent means *bivouac*, or *we have spent the night*, lies about half-way between Sétif and Biskra, in Algeria, and made a good stopping-place between these two points on our journey to the Sahara Desert. It is only five hours' ride from Sétif by the railway of the Compagnie Est Algérienne. It is well worth while to stay over at Batna and visit the extensive Roman remains at Lambessa and Timegad, the latter the most interesting ruins in Algeria. Lambessa was the ancient town of Lambæsis, founded in 169, A. D., which soon grew to be an important city, with a population of 60,000 souls. There are remaining two fine gates of the four by which the city formerly was entered. The north gate led to the main road between Constantine and Sétif, on which are to be found many remains of tombs and monuments to the dead, which the Romans so frequently erected on their highways.

The Prætorium is a splendid massive ruin, the columns and façade to the south presenting an imposing appearance. What blocks of solidity, what monuments for all time, are these grand arches, standing firmly and steadily in the same spot where they have held their place for over fifteen hundred years! This rectangular structure is ninety-two feet long and sixty-six feet broad, its height measuring forty-nine feet. The keystone over one of its gates bears the inscription, "Legio tertia Augusta." The interior is now used as a museum, and is filled with antiquities which have been unearthed in the immediate vicinity. There are ruins of the Roman baths, where we found some fine mosaics. Further to the east we found the Arch of Commodus, which is in a very good state of preservation, and just across the road, not far away, are the ruins of the Amphitheatre, of which very little remains, but sufficient to trace its circular shape without difficulty. This edifice is thought to have had the capacity of holding 12,000 spectators. It was destroyed but recently; they say persons are still living who have seen it almost in a state of wholeness.

We visited the Palace of the Legate and the Forum, and strolled through the remains of the Arch of Septimius Severus. Close to the Forum was the Temple of Æsculapius, of which there is very little left standing. But this, like the Amphitheatre, was also quite complete within the memory of the oldest inhabitant. We made a search for some of these persons to have this story corroborated, but, failing to find them, had to trust to the truthfulness of our *valet-de-place* and the guide-book.

Indeed, many of these fine old ruins have been destroyed by the Arabs or the unappreciative French colonists, their substantial stones being used for building some little hut or primitive dwelling of the settlers. There stands now in the French village an old Roman gate, which forms one side of a stone house.

The tomb of T. Flavius Maximus, commander of the Third Legion, has been restored lately by the French, and when his sarcophagus was replaced in its ancient resting-place after the renovation of the latter it was reinterred with military honors. But if Lambœsis proves so attractive to the archæologist, he will find much more to interest and to repay him if he visit the ruins at Timegad, the ancient Thamugas. This was a Roman town of much importance, situated, as it was, at the junction of six highways. We have not space here to enter into its history at length, but a full description of its ruins will be found in that well-known and charming book, the "*Footsteps of Bruce*," whose author came here in 1875. Ptolemy makes mention of this town as Thamutuda, and it has also been written of as Tamagada, Colonia Marciana Trajana Thamugas, and Colonia Ulpia Thamugas. There are inscriptions near the Forum which celebrate victories of Trajan over the Parthians, with a reference to the thirtieth Legion Ulpia.

This town had a position of great military importance. It has also been the seat of many religious wars and agitations. Here the great bishop, Optatus, became the leader of the Donatists in the year 400 A. D., and is spoken of by St. Augustine as one who ruled Africa. At Thamugas lived some other celebrated bishops: Novatus and Sextus in the third century, and Faustinus and Secundus in the fifth century. Between 300 and 400 A. D. the city was ruined, and restored again in the sixth century; the fortress shows marks of this restoration.

There are the ruins of a Christian church which was in existence under Gregory, in 646 A. D., when the Arab invasion took place. On the lintel of the door was inscribed:

> In temporibus Constantini Imperatoris
> Fl. Gregorio Patricio Johannes dux
> de Tigisi offeret domum Dei + Armenus.

This Christian church is the only ruin to be found of any interest on the west bank of the ravine, but on the east we found the remains of a Byzantine fortress, a theatre, forum, temple and triumphal arch, the latter much finer than the one at Lambessa; indeed, it is considered one of the most imposing ruins in Algeria. It has three arches, the centre one nearly twelve feet, and the side openings over eight feet in height. It is of the Corinthian style, and its four fluted columns, eighteen and one-half feet high, are in an excellent state of preservation. The original stones bearing the inscription have fallen from their place. This arch is built of sandstone, with columns, capitals, bases of the pilasters, brackets and entablature of white marble.

The remains of the Temple to Jupiter Capitolinus, although quite in ruins, show that once it must have been a magnificent structure. The forum is not yet fully unearthed, as there has been very little excavated since 1883, when the French Government placed these ruins under the supervision of M. Duthoit, architect-in-chief of historical monuments in Algeria, and he, with a corps of engineers, opened this mine of historical interest, and published plans and accounts of these two Roman towns.

As Algeria becomes better known and more frequented by the travelling world, I feel sure that this spot will prove one of its principal attractions. It is most convenient to take it in a journey from Algiers to Tunis, as it is only two hours from the main line between the two cities, and a day's carriage-drive from Batna enables the

traveller to stop at both places for hasty visits. The historical student and archæologist would, of course, prefer to make a longer stay. Possibly, when there is a greater influx of visitors, the hotel accommodations at Batna may be improved. At present, let him who comes here do so simply for the love of the historical, for all idea of comfort or luxury must be abandoned. The best hotel in the town is neither clean nor comfortable, but one can manage to endure it for the sake of the wealth of Roman ruins which lie so near. — *B. in the New York Evening Post.*

NOTES AND CLIPPINGS

Manganese Bronze. — The escape of the "*Calliope*" from Apia Harbor when all the other men-of-war were either sunk or beached has been attributed by some experts in England to the fact that her propeller was made of manganese bronze. The subject is referred to not merely for the sake of demonstrating the advantage which it is thought the "*Calliope*" derived from the character of her propeller, but also to show that a screw of this description really offers a substantial gain in the matter of speed. The "*Calliope*" made her way against the storm at the rate of one-half knot per hour, which represented the difference between what her engines were capable of doing when forced to their maximum and the power of the storm, and it very rarely happens that an extra half-knot is all that there is between safety and destruction. Yet this half-knot is not to be despised at any time, fair weather or foul, particularly should the voyage be a long one. The extra speed is acceptable, and the saving in coal, should it not be required, is by no means inconsiderable. The steel screw blades of several steamers plying between England and the west coast of South America were exchanged for others of manganese bronze, and, although the gain in one instance was only a quarter of a knot per hour, the effect was seen in the saving of between eight and nine tons per day in the coal account. In two ships running to Australia, in which a change of propellers was made from steel to manganese bronze of exactly the same surface and pitch, the speed was increased almost a knot an hour. Eight ships of the White Star Line have propellers of manganese bronze, as well as the "*City of New York*" and the "*City of Paris*" and two of the Cunarders. Other large companies have adopted the same material, and have been rewarded by increased speed and coal economy. Outside the circle of the mercantile marine there are numerous instances in the British Navy where a saving in the weight of the propeller of twenty to twenty-five per cent is claimed. The French have also adopted the same metal for some of their fastest vessels, notably the "*Forbin*" of nineteen and three-fourths knots, one of the fastest cruisers in the world. These examples have likewise been followed by Russia in some of her fast vessels. A peculiar kind of manganese bronze is used for this purpose which possesses great strength and toughness, said to be about equal to that of the best cast-steel, and as compared with gun metal, of which propellers used to be quite generally made, it possesses twice the strength, so that a great reduction can be made in the thickness of the blades, which therefore become finer and sharper. There is also a peculiar smoothness of surface, which results in a lessened skin friction, a very important consideration where high rates of speed are to be maintained, and the competition for first place among the ocean greyhounds is as keen and active as at present. Manganese-bronze castings are claimed to be smoother and less liable to warp than cast-steel. Freedom from pitting and corrosion preserves the blades for a long time in their original form, so that the life of the propeller will be fully equal to that of the vessel. This metal is considerably more expensive than steel, and, weight for weight, it is about a quarter more expensive than gun-metal, but the saving in weight over the latter and the fact of the pitting which steel is subjected to from the action of salt water make a very strong argument in favor of manganese bronze. When engines are developing into such magnificent and perfect specimens of mechanical art it would seem wise to supplement their powers with the most efficient and enduring propeller that can be found suited to the purpose. — *New York Times.*

The Eiffel Tower. — Much has been said about the origin of the modern Tower of Babel on the Champ de Mars, and the idea of its construction has been claimed for several persons. It will go down to posterity, however, as Eiffel's Tower, just as America was called after Amerigo Vespucci instead of Columbus. It is well-known that M. Eiffel — eminent engineer though he be — is no more originator of the tower than the Man in the Moon, but he took up the idea, had it elaborated, used his influence to popularize it, and finally superintended the colossal work until the idea and the plan became the wonderful reality which people of all nations are flocking to see. Here, in brief, is the history of the tower, which is nearly 1,000 feet high. In November, 1880, M. Sébillot, a French electrical engineer, conceived the idea of lighting Paris by electricity from one focus placed on a tower 300 metres high, the structure to stand in the Louvre court-yard or in the Place du Carrousel. In his report M. Sébillot pointed out that such a tower would be double the height of the Pyramid of Cheops or of the spire of Strasbourg Cathedral, but that modern facilities for dealing with steel and iron would render the construction possible. M. Sébillot took M. Bourdais — architect of the Trocadéro — into his confidence, and they both worked at the plan of the proposed tower, which was laid before the Society of Civil Engineers and then relegated to pigeon-holes. In 1883, however, another civil engineer — M. Nouguier — studied the project *minus* the electric-lighting propositions, and mooted it to M. Alexandre Eiffel, who had distinguished himself by the Douro Bridge and the Garabit Viaduct. M. Eiffel did not take kindly to the project at first, but on second thoughts he commissioned MM. Nouguier, Koechlin and Sauvestre to draw up a definite plan, which he adopted and carried out with energy and determination, despite immense opposition and even ill-will. M. Eiffel, therefore, is neither the projector nor the builder of the tower, any more than M. de Lesseps was the cutter of the Suez Canal, but he fostered the idea, fought for it with tooth and nail in pamphlets, lectures and newspaper articles, and never gave in, until to-day the tower, originally thought out in the brains of M. Sébillot and M. Nouguier, stands on the Champ de Mars as a marvel of modern science. — *London Daily Telegraph Paris Correspondence.*

How Large was Ancient Rome? — After carefully examining all the data we have, all the statements of the various ancient writers who allude to it, and all the facts which seem to bear on the question, I am convinced that in estimating the number at 4,000,000 I am rather understating than overstating it. It is much more probable that it was larger than that it was smaller. De Quincy also estimates the inhabitants of Rome at 4,000,000. I will only cite one fact, and then leave this question. The Circus Maximus was constructed to hold 250,000, or, according to Victor, at a later period probably, 385,000 spectators. Taking the smaller number, then, it would be 1 in 16 of all the inhabitants if there were 4,000,000. But as one-half the population was composed of slaves, who must be struck out of the spectators, when the circus was built there would be accommodation then for 1 in 8 of the total population, excluding slaves. Reducing again the number one-half by striking out the women, there would be room for 1 in 4. Again, striking out the young children and the old men and the sick and impotent, you would have accommodation for nearly the whole population. Is it possible to believe that the Romans constructed a circus to hold the entire population of Rome capable of going to it? — for such must have been the case were there only 4,000,000 of inhabitants. But suppose there were only 1,000,000 inhabitants, it is plain from the mere figures that it would never have been possible to half fill the circus. — *Blackwood's Magazine.*

Our Fir Stronger than Oak. — Some very interesting tests of woods native to Washington and others native to other timber sections of the country was made yesterday afternoon at the Northen Pacific car shops. The purpose was to demonstrate the relative strength of the woods.

There were present at the tests, master-mechanics Warner and Phipps, of the shops, engineers Lund and Haines and architect C. B. Talbot.

The timber tested was subjected to an actual breaking, on sticks 2 x 4 inches and four feet long, to centres, being one-fourth as long, thick and wide as an actual stringer as used by the railroad company in its trestle bridges. The test is important as there seems to have been but little information on that subject, and the impression has been that ordinary oak was stronger than fir. The tests show, however, that yellow fir is actually one-third stronger than eastern oak, and more than one-half stronger than eastern white pine. The breaking weight, placed squarely in the middle of each stick, was as follows:

No. 1. Old piece of yellow fir from yard; having decayed ends, six years in the weather; 3063 pounds.

No. 2. New soft piece fine grain yellow fir, similar to the best flooring timber, 3062 pounds.

No. 3. Old piece yellow fir, coarse grain and hard, broke short at 4320 pounds.

No. 4. New piece from the butt of tree, coarse grain, broke with a stringy fracture at 3635 pounds.

No. 5. New piece Michigan white pine, soft and clear, broke short at a weight of 1610 pounds.

No. 6. New piece of Michigan oak broke nearly short off at a weight of 2428 pounds.

All of the pieces of wood were subjected to the same clear span of 3 feet 9 inches, and the weight applied exactly in the middle.

As to the deflections, the following notes were made: Nos. 1 and 2, half an inch; No. 3, three-eighths of an inch; No. 4, five-eighths of an inch; No. 5, one-fourth of an inch; No. 6, one and one-eighth of an inch. — *Tacoma Daily Ledger.*

Corner-stone Records. — The fashion of placing objects like coins, inscribed bricks and so forth under or in the corner-stone of an important building is very ancient. M. de Sarzec found four such hiding places in the foundations of a palace built by a very ancient King of Chaldea called Gudea, whose headless statue is now in the Louvre. There were sacred cones and statuettes of clay, seals, and other amulets from protection against bogeys, and tablets or cylinders of clay inscribed. The fashion is found later in Babylonia and Assyria, Nabonidus, the last King of Babylonia, while restoring the temple of the sun at Larsa, found the original foundation cylinder, according to his own statement, on one which he placed in the cavity. He boasts that Kurigalzu (about B. C. 1350) and Esarhaddon (B. C. 680–667), had sought for it in vain. Unfortunately this most ancient cylinder has not been found. Perhaps he kept it for his own library. In his late excavations at Naucratis, Egypt, the English explorer Petrie, found under the four corners of a building erected during the Greek Ptolemy reigns miniature models of all the tools used in the work and small specimens of all the materials, from a tiny brick to a slip of gold and bit of lapis lazuli. These objects are now in the British Museum. — *Exchange.*

English Artists and Knighthood. — Sir Joseph Boehm, the sculptor, who is a German by birth, has three predecessors in history who received like honors from the British Crown. Sir Godfrey Kneller, who was also not of English birth; Sir Everett Millais, and Sir Frederick Leighton preceded him. Chantrey was knighted in 1835, Westmacott in 1837, and John Steel in 1876. Of architects there have been Chambers, Wyattville, Soane, Smirke, Barry, and Scott who were authorized to write Sir before their names. — *Exchange.*

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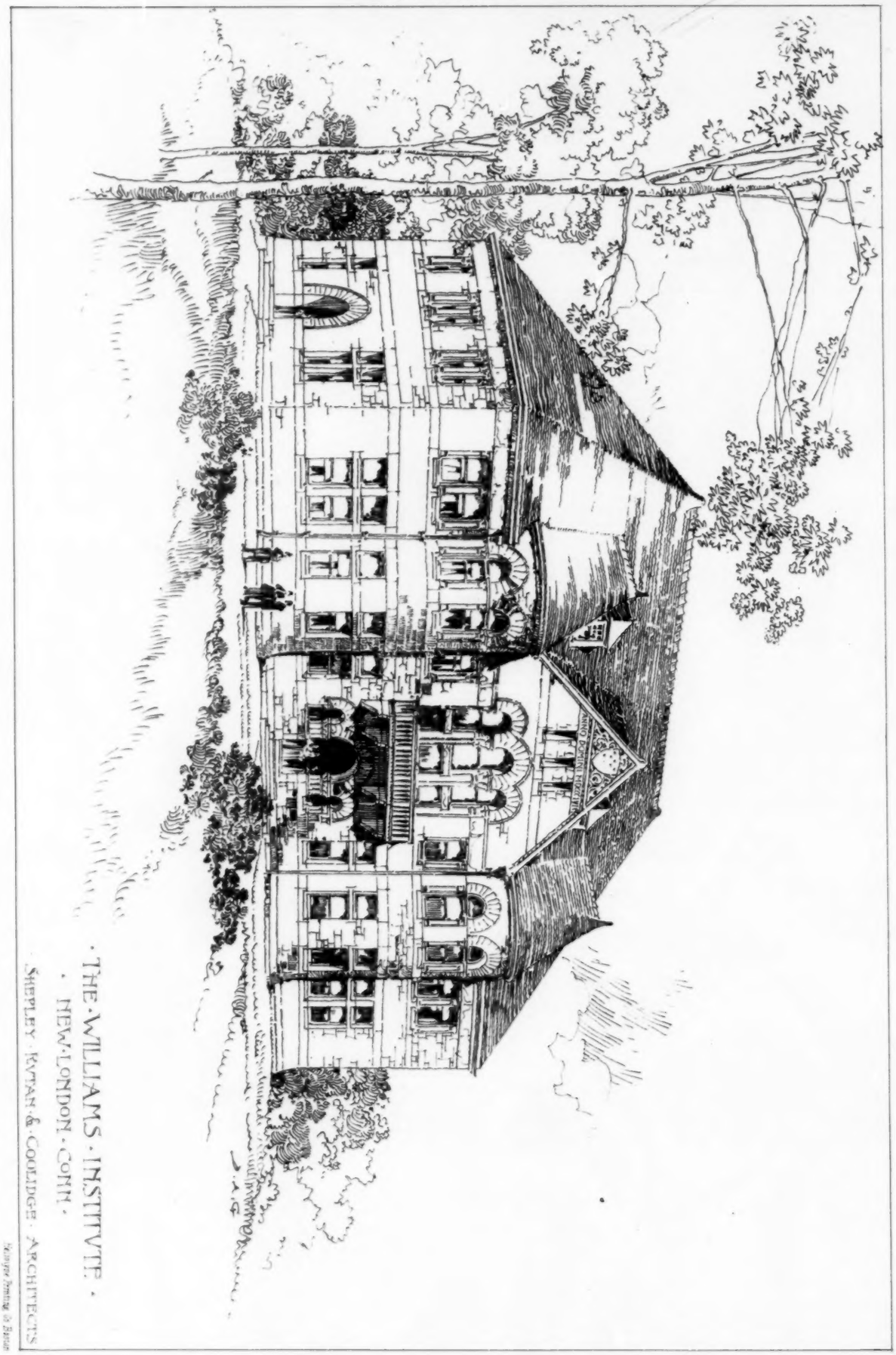

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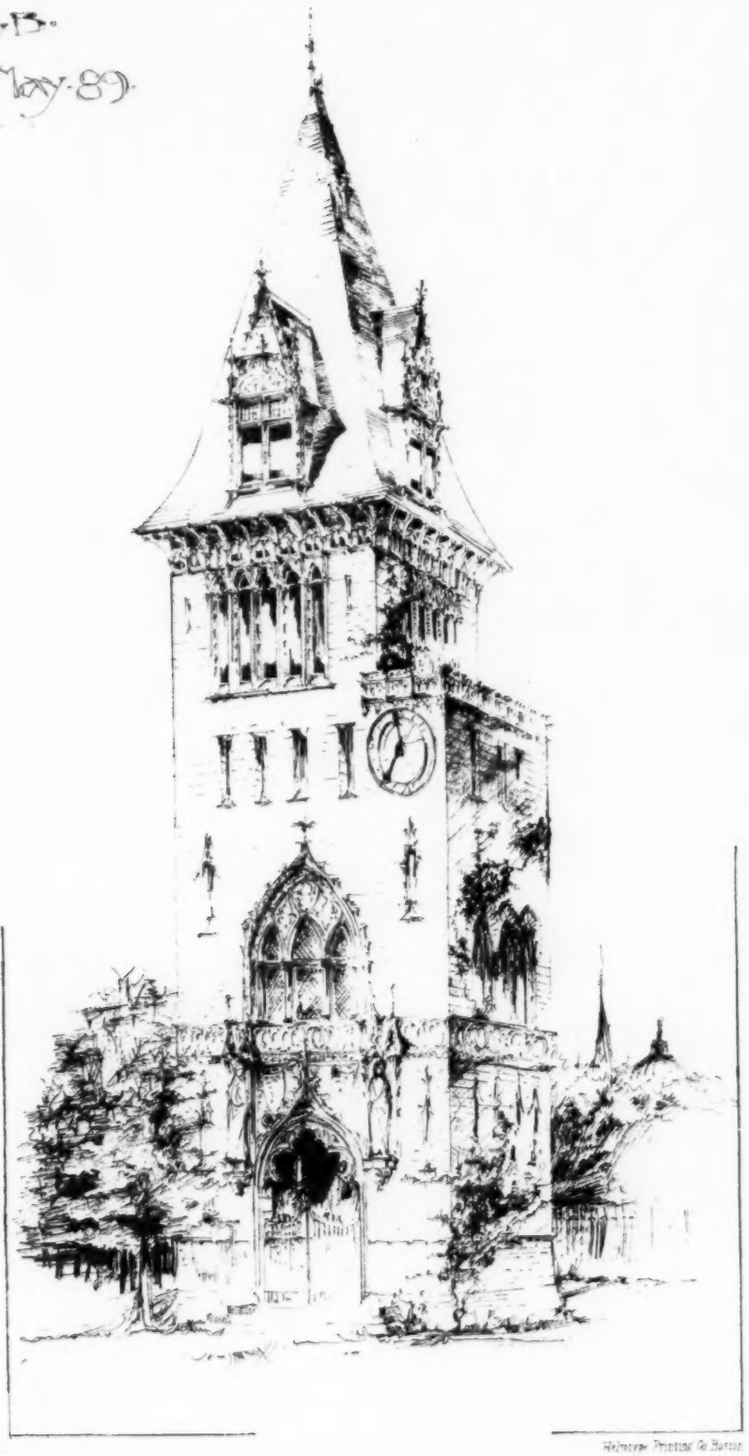

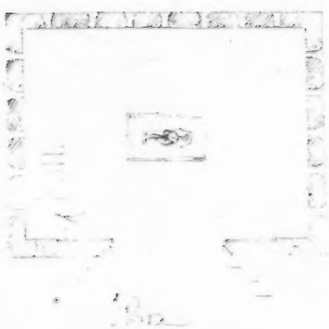

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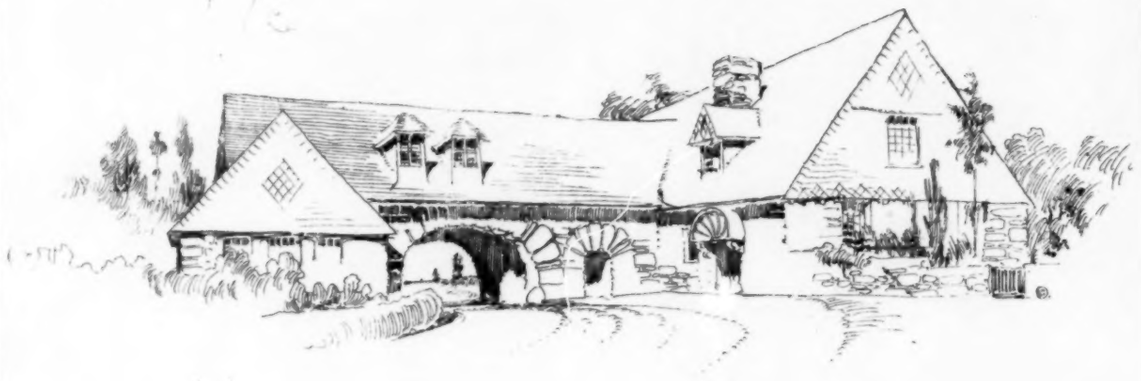

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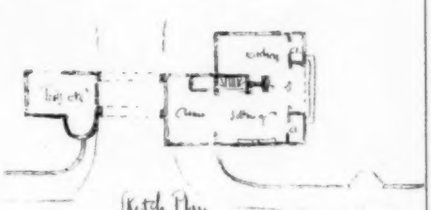

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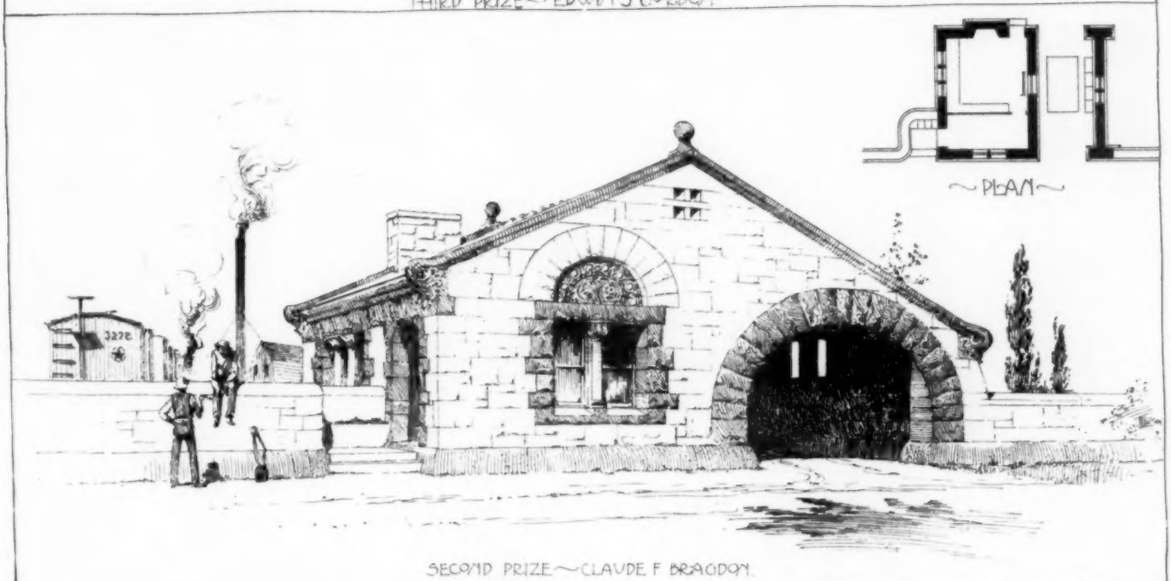

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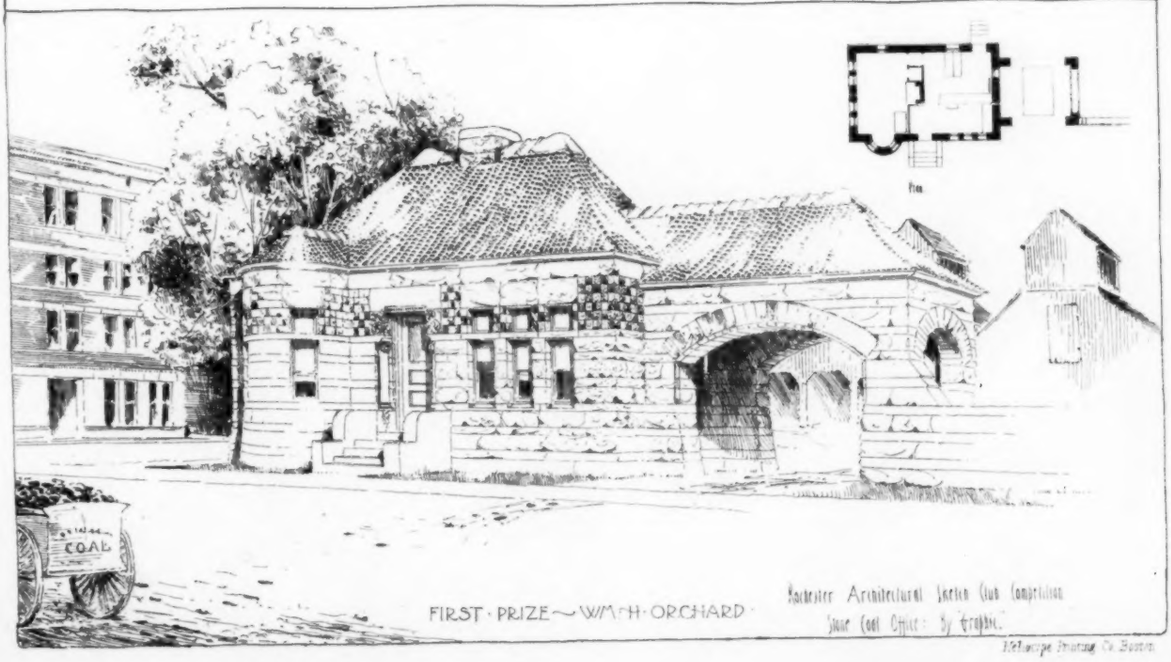

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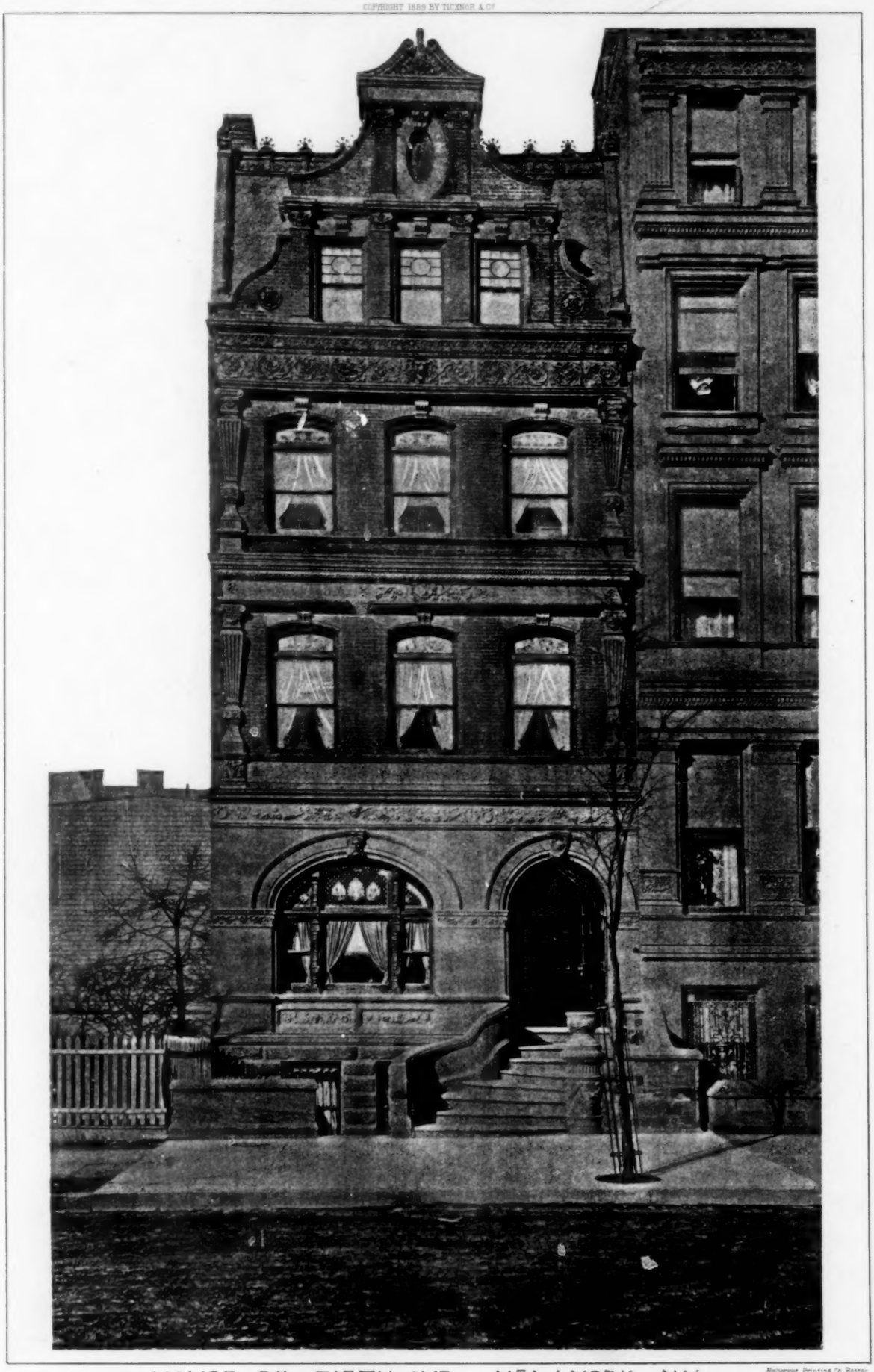

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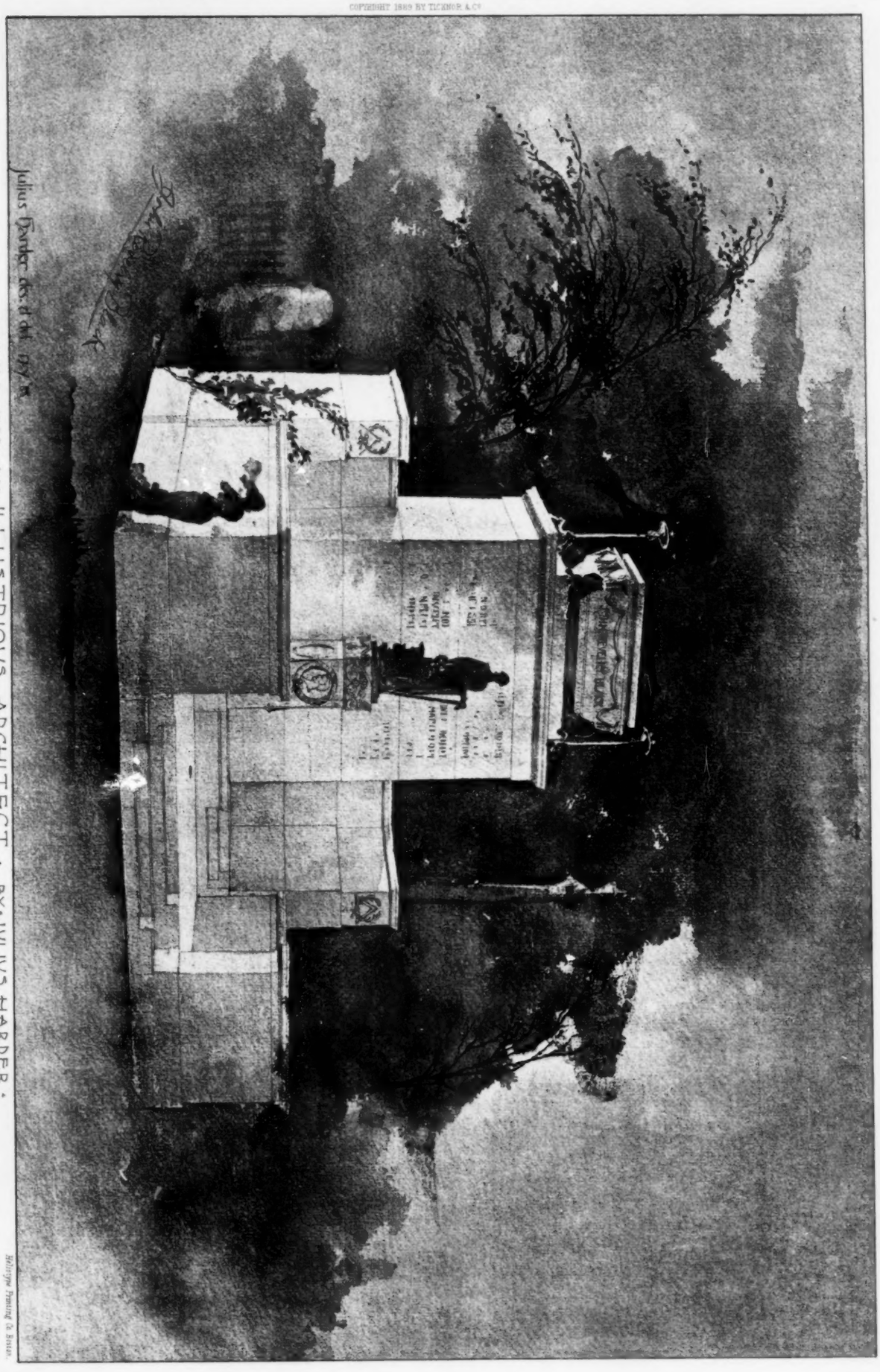

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